SDMS US EPA REGION V -1

SOME IMAGES WITHIN THIS
DOCUMENT MAY BE ILLEGIBLE
DUE TO BAD SOURCE
DOCUMENTS.

HAZARDOUS
SITE CONTROL
DIVISION

Remedial
Planning/
Field
Investigation
Team
(REM/FIT)

ZONE II

CONTRACT NO
68-01-6692

CH2M HILL
Ecology &
Environment

SOURCE CONTROL FEASIBILITY STUDY

OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

EPA 13-5M28.0

W65328.00

JULY 14, 1983

SOURCE CONTROL FEASIBILITY STUDY

OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

EPA 13-5M28.0

W65328.00

JULY 14, 1983

PD998.049.1

EXECUTIVE SUMMARY

High levels of polychlorinated biphenyls (PCBs) in soil and sediment in Waukegan Harbor and land owned by Outboard Marine Corporation (OMC) near the North Ditch, a small tributary of Lake Michigan, have been discovered by various public and private organizations since 1976. Concentrations of PCBs exceeding 30 percent on a dry weight basis (300,000 parts per million (ppm)) have been found in localized areas at the former OMC outfall. PCBs have penetrated into the layer underlying the harbor sediments near this outfall. The PCBs have spread laterally, contaminating soil, water, and sediment in Waukegan Harbor, Lake Michigan, and on adjacent land. PCBs have also entered the aquatic food chain, bioaccumulating in the top carnivores, such as salmon and trout.

The immediate threat that PCBs pose to the water quality of Lake Michigan and the potential threat to human health have prompted the U.S. Environmental Protection Agency (USEPA) to commission this feasibility study to recommend the most cost-effective source control remedial actions that are in accordance with the National Oil and Hazardous Substances Contingency Plan (NCP), 40 CFR 300.

This feasibility study is based on the premise that only PCBs in concentrations greater than 50 ppm need be addressed because these concentrations are regulated by 40 CFR 761. Previous investigations estimated that approximately 10,900 cubic yards (yd^3) of sediment, sand, and silt in Slip No. 3; 35,700 yd^3 of sediment in the Upper Harbor; and 175,800 yd^3 soil from the North Ditch/Parking Lot area are contaminated with PCBs in concentrations exceeding 50 ppm.

The procedures followed to develop the recommended alternatives for cleanup action included:

- Reviewing identified processes with the potential for contributing to PCB removal
- Screening these alternative processes based on engineering feasibility, environmental impact, cost, and conformance with site-specific objectives and the NCP
- Combining the processes that remained after screening into several remedial action alternatives for Slip No. 3, the Upper Harbor, and the North Ditch/Parking Lot area for further evaluation

- Recommending cost-effective source control remedial alternatives for each area (Slip No. 3, the Upper Harbor, the North Ditch, and the Parking Lot area)

- Interacting regularly with the regulatory agencies

The source control remedial action alternatives listed below were based on the feasibility study and consultation with USEPA. The alternatives resulted from a screening procedure that initially considered over 70 unit processes. The unit processes retained for further evaluation were assembled into the 21 alternative remedial action systems for initial screening. Detailed evaluation of 16 alternatives and subalternatives was conducted to address their advantages and disadvantages.

The alternatives are consistent with the requirements of the NCP for the selection of the lowest cost alternative that is technologically feasible, protects human health and the environment, and considers the need to balance funds under the Superfund Program. In view of these considerations, the five cleanup actions listed below comprise USEPA's recommended cleanup plan for the OMC site.

- Slip No. 3 and Upper Harbor: Subalternative I. This subalternative would be used only in conjunction with Alternative 6B. PCB-contaminated sediment, sand, and silt would be dredged from the localized area near the former OMC outfall. This material contains the greatest PCB concentrations in the harbor and represents 92 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor. This alternative would remove, fix, and dispose of an estimated 5,700 yd^3 of PCB-contaminated material containing about 286,500 lb of PCBs. The material would be disposed of offsite in a licensed chemical waste landfill. The estimated Order-of-Magnitude cost is $3,150,000.

- Slip No. 3 and Upper Harbor: Alternative 6B. A cofferdam with a slurry wall would be constructed around the perimeter of Slip No. 3, part of the Upper Harbor sediments would be dredged into the contained area, and then the containment area would be capped. The estimated Order-of-Magnitude cost is $6,100,000.

- North Ditch Area: Subalternative I. This subalternative would be used only in conjunction with Alternative 4B. PCB-contaminated soil would be excavated from the localized areas in the Crescent Ditch and Oval Lagoon. This material contains the greatest PCB concentrations in the North Ditch area and represents 57 percent of all the PCBs now found in the North Ditch/Parking Lot area. This alternative would remove and dispose of an estimated 5,500 yd^3 of PCB-contaminated soil containing about 440,500 lb of PCBs. The soil would be disposed of offsite in a licensed chemical waste landfill. The estimated Order-of-Magnitude cost is $740,000.

- <u>North Ditch Area: Alternative 4B</u>. PCB-contaminated soil would be contained and capped in the Crescent Ditch/Oval Lagoon area. A pipeline to bypass the east-west portion of the North Ditch would also be constructed (with partial excavation of PCB-contaminated soil to install the pipe). The PCB-contaminated soil from the bypass excavation would be placed in the Crescent Ditch/Oval Lagoon area before capping the area. The estimated Order-of-Magnitude cost is $4,210,000.

- <u>Parking Lot Area: Alternative 4</u>. PCB-contaminated soil would be contained and capped in the Parking Lot area. The estimated Order-of-Magnitude cost is $3,210,000.

The total estimated Order-of-Magnitude cost to implement the above alternatives is $17,410,000.

Public comments will be received during the 30-day public comment period. The USEPA Record of Decision issued at the end of the public comment period will determine specifically the alternatives to be implemented, with modifications, if any, resulting from public comment.

A conceptual design will be prepared for the remedial action alternative(s) selected by USEPA.

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

TABLES

TABLES (continued)

FIGURES

*Figures are found at back of section.

FIGURES (continued)

Section 1
INTRODUCTION

This report presents the results of a Source Control Feasibility Study (FS) to evaluate alternative means to remove, contain, fix, or otherwise treat polychlorinated biphenyl (PCB) contaminated soils on the Outboard Marine Corporation (OMC) site and PCB-contaminated sediments in the Waukegan, Illinois, harbor. This work was authorized by the United States Environmental Protection Agency (USEPA) on March 18, 1983, by Work Authorization 13-5M28.0.

PURPOSE

The purpose of this FS is to recommend the most cost-effective source control remedial actions in accordance with the National Oil and Hazardous Substances Contingency Plan (NCP) promulgated July 16, 1982 (47 FR 31180-31243; 40 CFR 300). A conceptual design of the selected remedial action alternatives, determined by the USEPA Record of Decision, will be presented in a separate report. The purpose of this report is to summarize the review and screening process used to develop the recommended alternatives.

SCOPE OF WORK

A comprehensive description of the scope of work was presented in the "Final Work Plan, Source Control Feasibility Study, OMC Site, Waukegan, Illinois," USEPA Work Authorization 13-5M28.0, dated March 28, 1983. A brief summary of the scope of work follows.

Task 1: Work Plan and Background Information Development

This task included development of a detailed work plan for conducting the FS; review of existing reports, maps, and other data; development of a concise history of the site and description of its current status; and a site visit.

Task 2: Development of Alternatives

Task 2 work included development of site-specific remedial response objectives and screening criteria; identification of remedial response alternatives, both from previous reports and based on experience; and an assessment of existing technology potentially applicable to remedial responses at this site. A comprehensive list of alternative unit processes was then developed, and preliminary screening was done to assess the potential applicability of each unit process to each of four areas of the project site. To conclude this task, the unit processes retained from the preliminary screening were assembled into remedial action alternatives for each of the project areas. Five or six alternatives were developed for each area. The alternatives selected were reviewed by USEPA and State of Illinois staff (Illinois Environmental Protection Agency and Attorney General's Office).

Task 3: Initial Screening of Selected Alternatives

In this task, the alternative remedial actions developed in Task 2 for each area were compared in terms of incremental (comparative) costs, environmental effects, and engineering feasibility. Based on the results of these comparisons, two to four alternatives for each area were retained for more detailed evaluation in Task 5. In addition, data gaps that became apparent during Tasks 2 and 3 were identified, and a laboratory testing program was proposed to USEPA to provide information needed for conceptual design (see Task 4).

Task 4: Additional Engineering Studies

Initially, no additional engineering studies were included in the scope of work. As a result of the data gaps identified in Tasks 2 and 3, USEPA authorized laboratory testing to evaluate the practicality of using portland cement (or other admixtures) to fix the contaminated sediments and to provide additional information about sediment dewatering and water treatment. It is anticipated that the results will be available about August 1, 1983. They will be presented under separate cover.

Task 5: Detailed Evaluation of Feasible Alternatives

The purpose of this task was to develop additional details on the alternatives retained from Task 3 and to determine which alternative would be most cost-effective. More detailed engineering aspects of the alternatives were considered, the potential environmental impacts of each alternative were identified in more detail, and Order-of-Magnitude cost estimates[1] were developed for each alternative. The results of this task were used to recommend one alternative for each area. The recommended alternatives were discussed with USEPA, and this report was prepared to summarize all the work in Tasks 1, 2, 3, and 5.

---

[1]The American Association of Cost Engineers defines an "Order-of-Magnitude" estimate as "An approximate estimate made without detailed engineering data. Examples include: an estimate from cost-capacity curves, an estimate using scale-up or scale-down factors and an approximate ratio estimate. It is normally expected that an estimate of this type would be accurate within +50 percent and -30 percent."

After USEPA review of this report, a revised work plan will be developed to complete the conceptual design of the selected alternatives.

Task 6: Conceptual Design

Conceptual design of the selected alternatives will consist of presenting, in report form, the data necessary to define the significant aspects of the conceptual design so that the design lead agency can accomplish the design. This task will be completed in coordination with the next lead agency, expected to be the U.S. Army Corps of Engineers (USCOE). The conceptual design report will include the descriptive text and figures necessary to document the recommended designs. Refined Order-of-Magnitude cost estimates for each alternative and a master implementation schedule will also be included. Authorization to proceed with Task 6 will be released after public comments have been revieved and the USEPA Record of Decision has been made.

Task 7: Additional Requirements

This task includes project management, quality assurance, and miscellaneous services not included elsewhere.

SITE DESCRIPTION

The OMC site is located near the intersection of Grand Avenue and Sheridan Road on the west shore of Lake Michigan in Waukegan, Illinois, about 37 miles north of Chicago and 10 miles south of the Wisconsin border (Figure 1-1).

Waukegan Harbor is an irregularly shaped harbor about 37 acres in area. For purposes of this FS, the harbor has been divided into two areas: Slip No. 3 and the Upper Harbor. These areas are shown on Figure 1-2. The PCB concentration for each of the two areas is also shown on Figure 1-2: Slip No. 3 with greater than 500 parts per million (ppm) and Upper Harbor with between 50 and 500 ppm. Water depths in the harbor generally vary from 14 to 25 feet (ft), with some shallower depths in parts of Slip No. 3. The harbor sediments consist of 1 to 7 ft of very soft organic silt (muck) overlying typically 4 ft of medium dense, fine to coarse sand. A very stiff silt (glacial till) that typically ranges from 50 to more than 100 ft thick underlies the sand. The entire harbor is bordered by 20- to 25-ft-long steel sheet piling, except at the Waukegan Port District boat launching areas and at the retaining wall near the harbor mouth. The sheet piles generally extend into the sand layer above the glacial till.

oil interceptor system. The floor drains discharged to the North Ditch and Waukegan Harbor. USEPA estimates that the discharge could have been as high as 20 percent (001, 068).

In 1976, USEPA began to regulate PCB disposal. OMC extensively sampled outfalls and sealed two outfalls entering the Crescent Ditch portion of the North Ditch, pursuant to an Administrative Enforcement Order by USEPA and IEPA. OMC declined to act on USEPA's demand for immediate action to remove PCB sediments. After negotiations among OMC, IEPA, and USEPA concerning responsibility for cleanup of the harbor and the North Ditch failed, legal actions ensued that have not been settled to date.

A third outfall, at the east end of the Crescent Ditch, currently discharges approximately 150,000 gallons per day (gpd) of noncontact, once-through cooling water. This cooling water supply partially originates from Slip No. 3 in Waukegan Harbor (001).

Numerous scientific investigations have been conducted to define the extent of the PCB contamination. Alternatives for removal/destruction of PCB-contaminated sediments in the harbor and the North Ditch area have been previously formulated and proposed. A listing of the data used to conduct the FS is presented in Section 8, Bibliography.

Remedial action, consisting of building a bypass around the North Ditch, was attempted in December 1979. This activity unearthed new areas of substantial PCB contamination beneath OMC's North Parking Lot. The bypass construction was postponed in early 1980, when USEPA updated its preliminary remedial action alternatives assessment and ultimate disposal and/or destruction alternatives to include the Parking Lot area of contamination.

Also in 1980, a special congressional appropriation in the USEPA budget and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) "Superfund" monies became available to begin the cleanup of Waukegan Harbor. USEPA contracted with WAPORA, Inc., to conduct an Environmental Assessment (EA) of the site. Funding, site constraints, and the time schedule modified the feasible alternatives discussed in the unpublished work by WAPORA, Inc. (002, 048). This funding was also used for planning and design work conducted by Mason & Hanger. In March 1983, the State of Illinois and USEPA signed the State Superfund Contract for this site, which included funding for this FS to assess alternatives.

EXTENT OF THE PROBLEM

Waukegan Harbor

Based on Mason & Hanger's Addendum to Final Report, dated May 1981 (008), and Mason & Hanger's Second Addendum to Final Report, dated March 1982 (016), about 42,900 cubic yards (yd^3) of upper sediments (muck) and 3,700 yd^3 of deep sediments (sand and silt) would have to be controlled to clean up areas of contamination exceeding 50 ppm PCB in Waukegan Harbor. These quantities were based on available data and were assumed to be accurate to an order of magnitude (076). The addenda define the following areas of PCB contamination:

- Slip No. 3--About 7,200 yd^3 of muck at thicknesses varying from 2 to 5 ft are contaminated by about 167,200 lb of PCBs, with concentrations typically exceeding 500 ppm. About 3,700 yd^3 of sand and silt at an average thickness of 7 ft are contaminated by about 138,000 lb of PCBs, with concentrations exceeding 10,000 ppm in a localized area near the former OMC outfall.

- Upper Harbor--About 35,700 yd^3 of muck at thicknesses varying from 1 to 5 ft are contaminated by about 5,000 lb of PCBs, with concentrations typically 50 to 500 ppm.

North Ditch/Parking Lot Area

Based on Mason & Hanger's Final Report, dated January 1981 (001), and on Weston's study of March 1982 (051), about 175,800 yd^3 of material would have to be controlled to clean up areas of contamination exceeding 50 ppm PCB in the North Ditch/Parking Lot area. These quantities were based on available data and were assumed to be accurate to an order of magnitude (076). The reports define the following areas of PCB contamination:

- Crescent Ditch--About 28,900 yd^3 of soil at an average thickness of 25 ft are contaminated by about 403,700 lb of PCBs. Typically, concentrations are 5,000 to 38,000 ppm. North of the die storage area, about 2,300 yd^3 of soil at an average thickness of 3 ft are contaminated by about 2,000 lb of PCBs. Concentrations are typically about 200 ppm.

- Oval Lagoon--About 14,600 yd^3 of soil at an average thickness of 27 ft are contaminated. There are about 85,500 lb of PCBs in the top 5 ft of the lagoon. Typically, concentrations in the top 5 ft are about 26,000 ppm. There were no data on the PCB concentrations or quantities below 5 ft.

- North Ditch--About 25,000 yd^3 of soil at an average thickness of 25 ft are contaminated by at least 4,300 lb of PCBs. About 200 ft of the western portion of the ditch are contaminated with concentrations typically in excess of 5,000 ppm PCB, and about 1,000 ft of the western and central portion of the ditch are contaminated with concentrations typically ranging from 500 to 5,000 ppm.

- Parking Lot--Beneath the eastern half of the existing Parking Lot, about 68,000 yd^3 of soil at thicknesses varying from 2 to 12 ft are contaminated. In the northwest portion of this contaminated area, an additional 37,000 yd^3 of soil at thicknesses varying from 5 to 30 ft are contaminated. Approximately 277,700 lb of PCBs are in these areas. The northwest corner and an area east of the Parking Lot are contaminated with concentrations typically in excess of 5,000 ppm PCB. The southwest corner of the Parking Lot is contaminated with concentrations typically ranging from 50 to 5,000 ppm.

ASSESSMENT OF POTENTIAL IMPACTS

Effects on Fish

The USEPA Ambient Water Quality Criteria for protection of freshwater aquatic life from PCB chronic toxicity is 0.014 parts per billion (ppb) (088). The lowest reported toxic concentration for freshwater aquatic life for PCB acute toxicity is 2.0 ppb (085). Total PCB concentrations in the surface water at the OMC site vary from about 0.6 ppb in Waukegan Harbor to less than 0.01 ppb in Lake Michigan directly offshore from Waukegan Harbor. About 60 percent of the total harbor PCBs in the water column is in the dissolved form. The water column PCB concentrations vary over a range of about 1.5 to 2.0 orders of magnitude (035).

Fish accumulate PCBs in their tissues by uptake from the water in which they live and by ingestion of aquatic organisms, insects, and plants that have taken up PCBs from their environment. It has been demonstrated that fish bioaccumulate PCBs to factors of 100,000 or more times the ambient water concentrations of PCBs. Available data indicate that PCBs are not excreted or degraded but are stored in skin and adipose (fatty) tissue. In USEPA studies on Lake Michigan fish, results ranged from concentrations of 2.7 to 187 ppm PCB in fatty tissue for all species. PCB concentrations in excess of 5 ppm were present in all trout and salmon more than 12 inches long. Positive correlations between size of the fish, percent fat, and age and the concentration of PCBs dissolved in the water column have also been found. Therefore, larger fish with a higher percent fat content, such as salmon and trout, accumulate high concentrations of PCBs. Bottom feeders, such as carp, also accumulate very high PCB concentrations from contact with PCB-contaminated bottom sediments (002, 021).

Bioaccumulation has been shown to occur at positions higher in the food chain. Carnivorous predators, such as large-mouth bass, have markedly higher PCB concentrations than species lower on the food chain (069, 002, 021).

Research has also shown that PCBs interfere with growth and reproduction of several species of fish. PCBs in the water column have been shown to inhibit phytoplankton photosynthesis. This will limit the growth of fish that require phytoplankton as a food source. High PCB concentrations in bottom sediments may interfere with the development of eggs that are deposited on the bottom during spawning. Fish fry mortality has a direct correlation to PCB levels in the water column, thereby artificially reducing fish populations. PCBs may ultimately act to diminish natural populations of fish species (002, 021, 049).

Effects on Animals

Physiological effects on animals caused by PCB exposure or ingestion include the following (069, 086, 087):

- Death of lower invertebrates
- Swelling of livers in various species
- Enzyme system disturbances in various species
- Growth inhibition in hamsters
- Decrease in immunosuppression in birds and mammals
- Hyperkeratosis, erethyma, blisters, and desquamation in rabbits
- Decreased reproduction in minks

The fact that PCBs bioaccumulate in animal tissues is also of concern because the contaminant remains in the food chain. PCB concentrations bioaccumulate without being degraded or eliminated and can reach levels that may be toxic to those organisms at the top of the food chain (085).

Impacts on Public Health and Safety

The magnitude of PCB effects on human health are not yet known. However, a severe accident involving PCB contamination of rice oil occurred in Kyushu, Japan, in 1968, implicating

PCBs as a health hazard. The Japanese called the accident Yusho (oil disease). The oil contained PCB concentrations of 2,000 and 3,000 ppm, now known to be in combination with chlorinated dibenzofurans and quaterphenyls (049, 065). Health effects were documented in more than 2,000 persons. Consumption of the contaminated oil resulted in skin lesions, blindness, hearing loss, jaundice, and abdominal pain. Uterine ulcers, stillbirths, and miscarriages also occurred. Infants born to mothers exposed to the contaminated rice oil exhibited skin, gum, and fingernail discoloration, indicating that at least some of the contaminants crossed the placental membranes. Other symptoms of Yusho toxicity in humans include: swelling of joints, waxy secretion of eyelid glands, general lethargy, joint pain, weakness and vomiting, abnormal menstrual cycles, and weight loss (085, 086, 087, 002, 021, 049).

Occupational exposure to PCB mixtures has caused chloracne and liver injuries in workers exposed to low levels. PCB effects on worker health from occupational exposure have also been documented (049, 002, 021).

Documented occurrences of high levels of PCB contamination in humans have almost all resulted from consumption of contaminated foods, accidentally or through accumulation in fatty tissues through the food chain. Inhalation of and skin contact with PCBs are not considered a significant source of contamination for the general public, but they are of concern in occupational exposure. The Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910) for an 8-hour work shift exposure to PCBs in air is 1.0 milligram per liter (mg/l) for PCBs with 54 percent chlorine (Aroclor 1254) and 0.5 mg/l for PCBs with 42 percent chlorine (Aroclor 1242). There is no OSHA standard set for PCBs with 48 percent chlorine (Aroclor 1248). Samples taken by the Environmental Research Group, Inc. (ERG) on September 3, 1980, for USEPA detected Aroclor 1242 and Aroclor 1248 in Waukegan Harbor sediments. Aroclor 1254 was below detection limits (079).

USEPA Ambient Water Quality Criteria for carcinogenicity protection of human health from ingestion of water and organisms is 0.00079 ppb at the 10^{-5} risk level. Concentrations that have a risk level of 10^{-5} are estimated to result in an increase of one cancer death per 100,000 people who experience PCB exposure over a lifetime. Total PCB concentration vary from 0.6 ppb in Waukegan Harbor to less than 0.01 ppb in Lake Michigan directly offshore from Waukegan Harbor (035). There is an emergency water supply intake for Waukegan near the mouth of the harbor.

Potential Impacts of No Action

Under the No Action alternative, surface-water bodies, sediments, and soils would remain contaminated with a toxic substance regulated under Toxic Substances Control Act (TSCA). Socioeconomic impacts would continue and might include the following (085):

- Loss of fish for human consumption
- Reduction or loss of commercial fishing
- Decline in property values
- Depressed area growth
- Reduction in recreational activity, such as boating and sport fishing
- Reduction in commercial harbor access due to lack of harbor dredging
- Expenditures for laboratory analysis of area water, soil, and biota samples
- Occupational exposure
- Expenditures for medical services
- Expenditures for legal services

Slip No. 3 and Upper Harbor. The No Action alternative will leave an estimated 305,200 lb of PCBs in Slip No. 3 with concentrations in excess of 10,000 ppm in the localized area of Slip No. 3 and in excess of 500 ppm in the rest of Slip No. 3 sediments; and 5,000 lb of PCBs in the Upper Harbor in concentrations between 50 and 500 ppm. Approximately 98.4 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor sediments are located in Slip No. 3. PCBs in these concentrations are regulated by 40 CFR 761 under TSCA.

Slip No. 3 and the Upper Harbor PCBs will continue to contribute to the estimated 22 lb of PCBs released into Lake Michigan each year from Waukegan Harbor water (based on a steady state model) (035). The Waukegan area will continue to represent the most significant contributor to Lake Michigan PCB contamination, since it holds the largest known uncontained PCB mass in the lake basin. The potential for volatilization of PCBs will continue, contributing to the estimated 12 to 40 lb released from the harbor into the local airshed each year (007, 030, 035). Channel dredging has been suspended because of PCB contamination, and shipping access to the harbor will eventually be eliminated. Harbor maintenance dredging of PCB-contaminated soils is expensive because of disposal and handling requirements. Huron Portland Cement and National Gypsum are now and will continue to be directly impacted, since they depend on the harbor to receive raw material shipments.

North Ditch/Parking Lot Area. The No Action Alternative will leave an estimated 773,200 lb of PCBs in the North Ditch/Parking Lot area with levels of PCB contamination in excess of 10,000 ppm in a localized area of the Crescent Ditch and Oval Lagoon and between 50 and 10,000 ppm in the rest of the North Ditch/Parking Lot area soils. Offsite drainage that enters the North Ditch will continue to become contaminated, discharging PCBs into Lake Michigan. It is estimated that this source discharges 7 to 20 pounds per year (lb/yr) of PCBs into the lake annually (032, 035).

Existing volatilization of PCBs from the North Ditch waters is estimated to be 15 lb/yr (004). Although volatilization of contaminated soils does not appear to be occurring now, the potential exists if existing soils are disturbed (004). Grading, trenching, drilling, digging, or other activities necessary for utility installation, drainage, or other construction projects could cause volatilization of PCBs. Under the No Action alternative, PCBs will continue to be released into the airshed through volatilization.

Groundwater is within 3 feet of the surface of the Parking Lot, resulting in contamination of these waters. It is estimated that these slowly moving waters will begin releasing some 8 lb/yr of PCBs into Lake Michigan in approximately 60 years (002). This will result in further contamination of local water and soil, which could continue for decades.

The hydrologic system is currently not well enough understood to determine the extent of past or future PCB contamination by groundwater movement from the North Ditch. Without cleanup action, groundwater contamination will still exist.

OBJECTIVES AND CRITERIA

The proposed site-specific remedial response objectives and criteria for the OMC Hazardous Waste Site have been developed in accordance with the NCP. These objectives and criteria have been used to select and develop the remedial response measures for the OMC site.

Objectives

The primary objectives of this FS are to:

- Recommend cost-effective source control remedial action(s) in accordance with the NCP under statutory requirements of CERCLA.
- Prepare a conceptual design of the remedial action alternative(s) selected by the USEPA Record of Decision.

Criteria

To meet the project objectives, the following site-specific criteria were used in considering alternatives and in developing our recommendations:

- Economic comparisons were made on a present-worth basis, considering both initial construction (capital) costs, and operation and maintenance (O&M) costs, as applicable. For purposes of reducing O&M costs to present worth, a 20-year life was used, with a discount rate of 10 percent (as established by Office of Management and Budget Circular No. A-94).

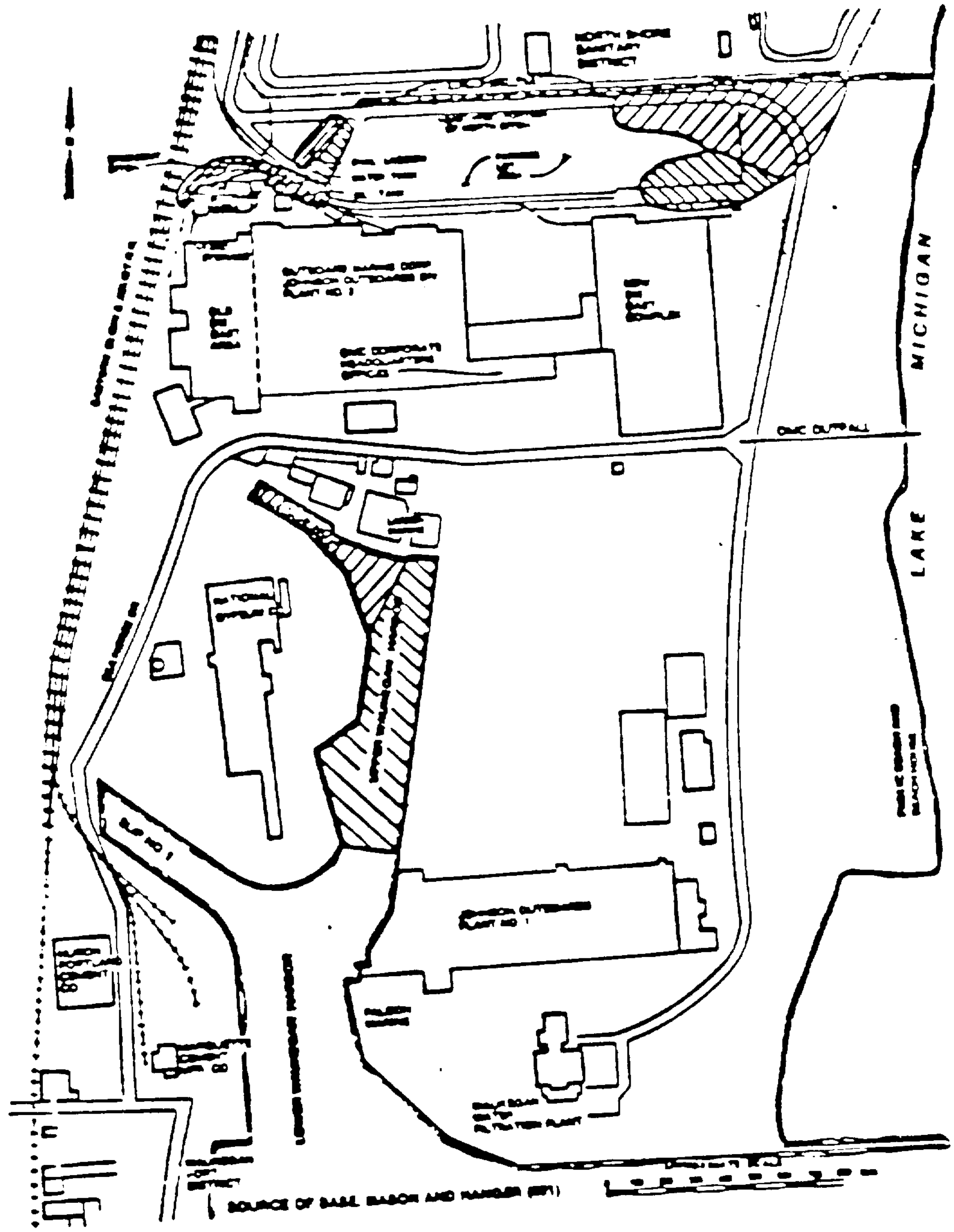
- During initial screening, alternatives whose apparent cost far exceeded (e.g., by a factor of about 10 or more) the costs of other alternatives were usually excluded from further consideration, unless there were substantially greater public health or environmental benefits.

- During detailed analysis of the alternatives, the primary cost selection criterion was to identify alternatives that would remove or contain the greatest mass of PCBs per present-worth dollar. In the case of alternatives with approximately equal costs per pound of PCBs removed, the selection criterion was to remove, secure, or reduce exposure to material most likely to adversely affect the public health and welfare or the environment.

- In considering environmental effects, alternatives were eliminated when long-term adverse environmental effects resulting from implementation would exceed the long-term mitigation benefits expected (i.e., the alternative is not expected to achieve adequate source control). The potential effects were evaluated based on engineering judgment, in a qualitative manner; quantitative analyses were not used.

- Alternatives were generally eliminated when it was judged that the permit acquisition process would unnecessarily delay (i.e., beyond mid-1984) project startup.

- In general, alternatives that were suitable from an engineering practice viewpoint and judged to provide an adequate degree of protection of the public health and welfare and the environment were retained, when they could be accomplished in a reasonable time (i.e., from mid-1984 to late 1986).



LEGEND

PCB CONCENTRATIONS OVER 500 PPM

PCB CONCENTRATIONS BETWEEN 50 AND 500 PPM

FIGURE 1-2
SITE MAP
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

CH2M HILL

W65328.D0

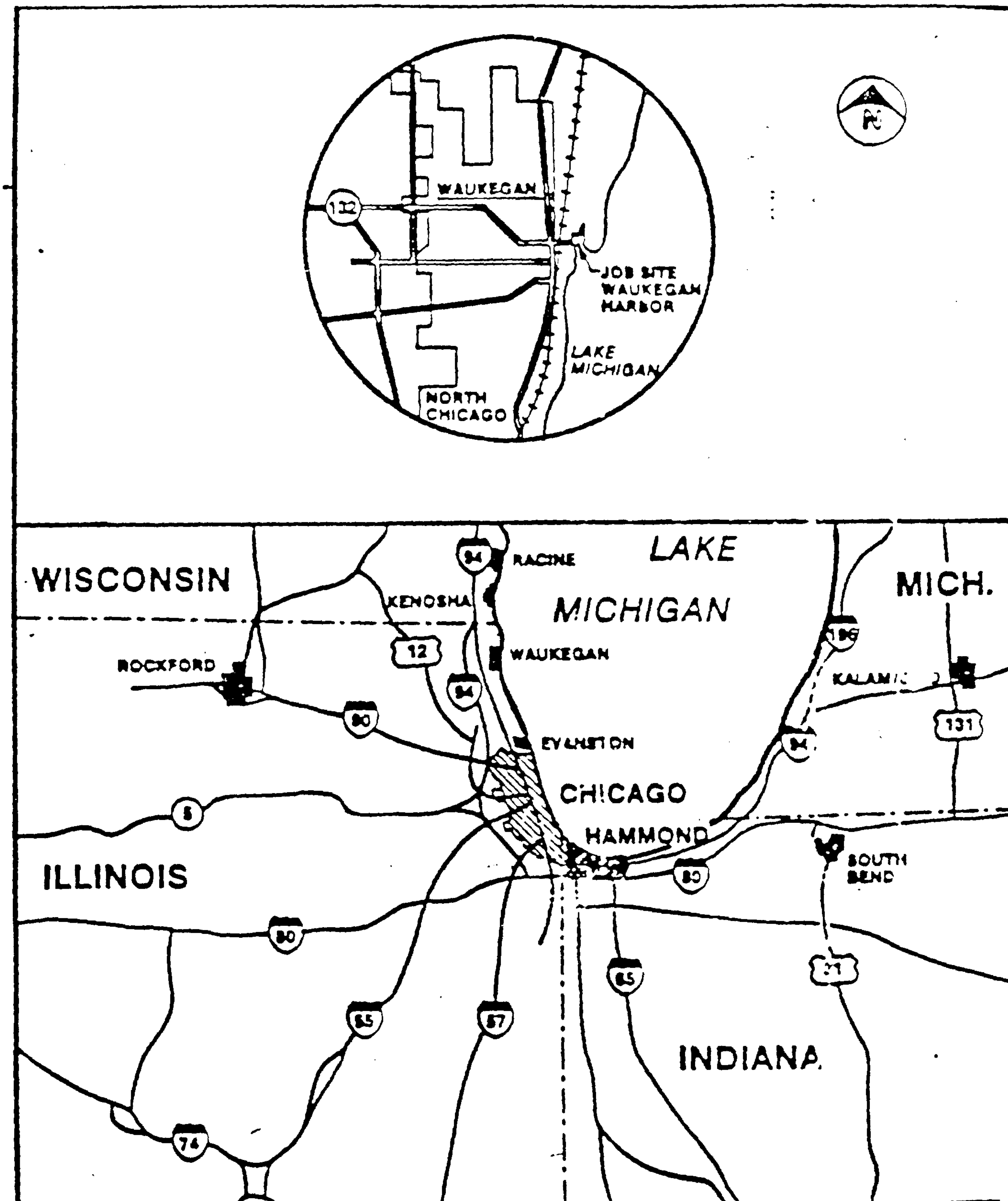
Project timing was determined by USEPA to be a critical criterion for the OMC site.

- Alternatives that relied on unproven or experimental technology were generally eliminated since their feasibility and reliability have not been demonstrated.

- Alternatives that required special-order, special-manufacture, or limited-availability equipment or products, because of time delays, were generally eliminated in favor of techniques using conventional/available equipment or products, when similar results could be achieved.

- Commonly available, conventional construction and process equipment and products were selected to the maximum extent possible, whenever such items conformed to the preceding criteria.

In summary, these criteria were directed toward developing remedial actions that would be effective in cleaning up the site, environmentally sound, economical, and constructible in a timely manner with generally available procedures.



SOURCE: MASON AND HANGER ([illegible])

FIGURE 1-1
LOCATION MAP
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
EPA 13-5M28.0

W85328.00

Section 2
PRELIMINARY SCREENING

This section summarizes the preliminary screening of the unit processes for remedial action alternatives. The unit processes were evaluated based on the preliminary screening criteria and in accordance with the other site-specific remedial response objectives and criteria discussed in Section 1. The preliminary screening process narrowed the alternatives down to five or six for each area. The retained alternatives were evaluated in more detail during initial screening (see Section 4).

PRELIMINARY SCREENING CRITERIA

All unit processes identified were subjected to preliminary screening criteria to determine whether further evaluation was warranted. Development of preliminary screening criteria was based on existing technology, availability, time requirements, economics, and the overall remedial response objectives and criteria presented in Section 1. The preliminary screening criteria used to evaluate or eliminate unit processes consisted of the following:

- Alternatives using unproven or conceptual technologies were eliminated based on critical timing.
- Alternatives previously evaluated and eliminated by others were eliminated when CH2M HILL concurred, based on elements of the NCP (cost, environmental effects, and acceptable engineering practices).
- Alternatives that were inefficient or required an unreasonable length of time to implement were eliminated.
- Alternatives that were ineffective in reducing exposure to or potential health effects of PCBs were eliminated.
- Alternatives that were judged not technically feasible were eliminated.
- Alternatives having conceptual costs that were not cost-effective (i.e., with costs an order of magnitude or more higher than other alternatives) were eliminated.
- Alternatives not in conformance with the site-specific objectives were eliminated.
- Alternatives not consistent with the NCP were eliminated.

The unit processes presented below describe various new technologies and also borrow from proven technologies developed for other engineering fields with similar needs. A list of potential unit processes for remedial action alternatives, as well as a summary of the reasons for their further evaluation or elimination, is presented in Table 2-1. Alternatives were divided into the following categories according to their applicability to the problem:

- No action
- In-place destruction
- In-place fixation
- In-place PCB separation and removal
- PCB-contaminated solids removal
- Sediment dispersal control
- Surface water and groundwater control
- Bypass
- Initial solids dewatering
- Secondary solids dewatering
- Fixation
- Water treatment
- Onsite storage/disposal
- Offsite storage/disposal
- Transportation

NO ACTION

Under the No Action alternative, surface water bodies, soils, and sediments would remain contaminated with a toxic substance regulated under TSCA. Socioeconomic impacts would and might include the following (085):

- Loss of fish for human consumption
- Reduction or loss of commercial fishing
- Decline in property values
- Depressed area growth
- Reduction in recreational activity, such as boating and sport fishing
- Reduction in commercial harbor access due to lack of harbor dredging
- Expenditures for laboratory analysis of area water, soil, and biota samples
- Expenditures for medical services
- Occupational exposure
- Expenditures for legal services

Table 2-1 (page 1 of 8)

LIST OF UNIT PROCESSES FOR REMEDIAL ACTION ALTERNATIVES
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Alternative	Slip No. 3	Upper Harbor	North Ditch and Parking Lot Area: North Ditch	Oval Lagoon	Crescent Ditch	Parking Lot	Comments
NO ACTION	X*	X	X	X	X	X	Health effects, environmental hazard, bioaccumulation, PCBs are not biodegradable (005)**.
IN-PLACE DESTRUCTION							
UV/Ozonolysis							Pilot stage, closed system only, unable to penetrate deep deposits, not available for in-place use (005).
Biodegradation							Laboratory stage only, closed system only, not available for in-place use (001,005).
Chemical oxidation							Conceptual (001, 005).
Radiation (gamma and electron beam)							Conceptual (005).
IN-PLACE FIXATION							Will eliminate much benthic life, no data available on long-term effects and stability, landfill waiver required, PCBs will remain.
Sorbents							Conceptual, high concentrations would not be reduced sufficiently (005).
In-place stabilization							Successfully demonstrated in Japan, but no long-term-effects data; future dredging of harbor not possible (001, 005).
Impermeable membrane seal							Conceptual, limited lifetime, anaerobic biological activity will occur (005).
IN-PLACE PCB SEPARATION AND REMOVAL							
Retrievable sorbents							Conceptual, no field testing (005).
Bioharvesting							Conceptual, limited effectiveness (005).
Oil-soaked mats							Conceptual (005).
Solvent extraction							Conceptual, no field testing, solvents possibly toxic (005).

*X represents unit processes selected for further evaluation during initial screening.
**Refers to document control number (Section 8); alternatives not referenced were developed by CH2M HILL.

PD998.058.1

Table 2-1 (page 2 of 8)

LIST OF UNIT PROCESSES FOR REMEDIAL ACTION ALTERNATIVES
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Alternative	Slip No. 3	Upper Harbor	North Ditch and Parking Lot Area: North Ditch	Oval Lagoon	Crescent Ditch	Parking Lot	Comments
PCB-CONTAMINATED SOLIDS REMOVAL							
Freezing before removal							Not cost-effective.
Mechanical dredge							Possible that dredged sediments could be fixed directly.
• Clamshell	X	X					High degree of sediment suspension, barge required for receipt and transport of spoils, requires closeoff, poor control of bottom cut, difficult to estimate quantity of cut, increases solids concentrations, and reduces water treatment (001, 005).
• Dragline							High degree of sediment suspension, barge required for receipt and transport of spoils, poor control of excavation (005).
• Dipper							High degree of sediment suspension, barge required for receipt and transport of spoils (005).
• Bucket ladder							High degree of sediment suspension, barge required for receipt and transport of spoils, not locally available (005).
• Sauerman							Moves large amount of material, high degree of sediment suspension, no floating equipment required.
Hydraulic dredge							Sediment dewatering and supernatant treatment required, high removal efficiency.
• Hopper							Extensive maneuvering space required (005).
• Cutterhead pipeline suction	X	X					Low-to-medium degree of sediment suspension, tug required (005).
• Dustpan							Low degree of sediment suspension, may be difficult to operate in Slip No. 3, not available for use in Midwest (005).
• Mudcat							No capacity for deep water, dredge depth of 10 to 15 feet, water depth of 21 inches required (005).
• Sidecaster							Extensive maneuvering space required (005).

PD990.058.2

#4

Table 2-2 (page 3 of 4)

LIST OF UNIT PROCESSES FOR REMEDIAL ACTION ALTERNATIVES
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Alternative	Slip No. 3	Upper Harbor	North Ditch and Parking Lot Area: North Ditch	Oval Lagoon	Crescent Ditch	Parking Lot	Comments
Pneumatic dredge							Less sediment dewatering and supernatant treatment required than for hydraulic dredge, dredged sediments could be fixed directly.
• Airlift							Not commonly available equipment (005).
• Pneuma	X	X					Degree of sediment suspension questionable, used in Washington to remove PCBs, may be subject to import restrictions, low demonstrated production rate (005).
• Namtech							May be available, may pump up to 40 percent solids, currently being field tested, in early stages of development.
• Oozer	X	X					Very low degree of sediment suspension, not currently available in U.S., may be subject to import restrictions (005).
Excavation equipment							Noise, dust, disposal required.
• Scraper							Excavation site relatively dry, dewatering of harbor could cause stability problems (005).
• Front end loader			X	X	X	X	Dewatered site required, dewatering of harbor could cause stability problems (005).
• Backhoe			X	X	X	X	Dry site not required (005).
• Dragline crane							Dry site not required, poor control of excavation (005).
SEDIMENT DISPERSAL CONTROL							
Single silt curtain							Not watertight, some sediments pass through (001).
Double silt curtain	X	X					Not watertight, more effective than single silt curtain (001).
Water-inflated dam							Watertight, not cost-effective (001).
Sheet piling	X	X					May not be cost-effective.

PD990.058.3

Table 2-1 (page 4 of 8)

LIST OF UNIT PROCESSES FOR REMEDIAL ACTION ALTERNATIVES
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5H28.0

Alternative	Slip No. 3	Upper Harbor	North Ditch and Parking Lot Area: North Ditch	North Ditch and Parking Lot Area: Oval Lagoon	North Ditch and Parking Lot Area: Crescent Ditch	North Ditch and Parking Lot Area: Parking Lot	Comments
SURFACE WATER AND GROUNDWATER CONTROL							
Cofferdam	X						Reduces inflow of surface and groundwater, provides structural support, requires well points and pumping, may be required in Slip No. 3 to reach deep sediments, volatilization of PCBs (001).
Dewatering	X		X	X	X	X	Lowers groundwater table (005).
Injection of grout							Reduces inflow of groundwater, not cost-effective, not possible to fully evaluate effectiveness (005).
Sheet piles			X	X	X	X	Reduces inflow of groundwater, provides structural support (001).
Slurry walls			X	X	X	X	Reduces inflow of groundwater (001).
BYPASS							
Grading							Redirects site surface flow, North Ditch or replacement required for discharge of upper basin surface water (003).
Pipeline			X	X	X		Reduces PCB discharges to lake, contaminated groundwater movement, and contaminated soil production (001).
• Bypass existing storm sewers and drainage ditch into underground storm sewer.							
• Divert present discharge from OMC to storm sewer.							
• Install new catch basins near Crescent Ditch and connect to storm sewer.							
Lined open ditch			X	X	X		May be less cost-effective than pipeline.
Temporary pumphouse							Inefficient (005).

PD998.058.4

Table 2-1 (page 3 of 8)

LIST OF UNIT PROCESSES FOR REMEDIAL ACTION ALTERNATIVES
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-3M28.0

Alternative	Slip No. 3	Upper Harbor	North Ditch and Parking Lot Area: North Ditch	North Ditch and Parking Lot Area: Oval Lagoon	North Ditch and Parking Lot Area: Crescent Ditch	North Ditch and Parking Lot Area: Parking Lot	Comments
INITIAL SOLIDS DEWATERING							
No Dewatering							Not cost-effective to truck and/or dispose of untreated water (001, 002, 005).
Lagoon on OMC property	X	X					May not have available land (001, 002, 005).
Portable Sediment Processing System	X	X					Pilot scale successfully demonstrated.
• Clarifier bins							Effluent equal to about 131,000 mg/l.
• Hydrocyclones							Effluent equal to about 88,000 mg/l.
• Uni-Flow filter (5")							Effluent equal to about 450 mg/l.
North Ditch as dewatering basin	X	X					Simple.
Barge storage	X						Not land based.
Thickening with other project area solids	X	X					Reduces degree of dewatering required.
Slip No. 3 as dewatering basin							Sheet pile installation and other necessary modifications not cost-effective.
Dehydro drying beds							May not have available land or time.
Gravity thickener							Specific gravity of solids is excessive, torque overload may occur.
SECONDARY SOLIDS DEWATERING							
Mechanical dewatering/belt press	X	X	X	X	X	X	Nonhomogeneous solids, would require screening, degritting, and grinding to eliminate rocks and sticks.
Treat with other solids	X	X	X	X	X	X	Air dry and mix with other project solids.
FIXATION	X	X	X	X	X	X	Easy to handle but more weight to transport (005).
WATER TREATMENT							
No Water treatment							Unacceptable.

FD990.058.5

Table 2-1 (page 6 of 8)

LIST OF UNIT PROCESSES FOR REMEDIAL ACTION ALTERNATIVES
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Alternative	Slip No. 3	Upper Harbor	North Ditch and Parking Lot Area: North Ditch	North Ditch and Parking Lot Area: Oval Lagoon	North Ditch and Parking Lot Area: Crescent Ditch	North Ditch and Parking Lot Area: Parking Lot	Comments
Flocculation/sedimentation	X	X	X	X	X	X	Effective to 1-10 µg/l (001, 002, 008).
• Alum, 30 to 66 ppm							
• Nalco 8103, 5 to 15 ppm							
Filtration	X	X	X	X	X	X	Yields lower effluent PCB concentrations (001, 008).
Carbon adsorption	X	X	X	X	X	X	Yields effluent PCB concentrations less than 1 ppb (001, 008).
Kiensorb							New technology; may be cost-effective alternative to carbon adsorption.
UV/Ozonolysis							Yields low effluent PCB concentrations, requires large surface area and thin water film to be effective (005).
Catalytic reduction							Ineffective.
Wet oxidation							Not cost-effective, conceptual.
High-efficiency boilers							High fuel costs, efficient in reducing PCB concentrations.
Chlorinolysis							Unknown byproducts; high-pressure, low-temperature process.
The Goodyear process							No field testing.
The Sunohio process							Field equipment is available; breaks down PCBs into primary components.
Use of North Shore Sanitary District Wastewater Treatment Facility							Lagoons may be available for use as a temporary holding or curing cell.
ONSITE STORAGE/DISPOSAL							
Landfill							Proximity to Lake Michigan, possible flooding, high groundwater table, no long-term data on reliability, potential delays due to siting permit process, requires long-term monitoring, TSCA waiver required (001, 002, 005).

Table 2-1 (page 7 of 8)

LIST OF UNIT PROCESSES FOR REMEDIAL ACTION ALTERNATIVES
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Alternative	Slip No. 3	Upper Harbor	North Ditch and Parking Lot Area: North Ditch	Oval Lagoon	Crescent Ditch	Parking Lot	Comments
Containment/encapsulation	X			X	X	X	Proximity to Lake Michigan, possible flooding, high groundwater table, requires long-term groundwater monitoring, may require permit (001, 002, 005).
PCB extraction							Ongoing, approved site-specific research and development work.
Chemical destruction							Conceptual (001, 002).
Biological breakdown							Laboratory stage only (001, 002).
Incineration and landfill ash	X	X	X	X	X	X	Technology not readily available for this scale, not cost-effective (001, 002, 005).
Water disposal	X	X	X	X	X	X	Water returned to natural waterways must have PCB concentrations less than 1 ppb.
OFFSITE STORAGE/DISPOSAL							
Landfill	X	X	X	X	X	X	Long-term disposal (001, 002, 040).
• SCA Chemical Waste Services, Model City, New York							More than 500 miles. Licensed to receive PCBs. Barge transportation available.
• Clermont Environmental Reclamation, Williamsburg, Ohio							350 miles. Licensed to receive PCBs.
• Chemical Waste Management, Calumet City, Illinois							[illegible] miles. Not licensed for PCBs.
• Browning Ferris Industries, Lake County, Illinois							13 miles. Not licensed for PCBs.
• New Site No. 1, Lake County, Illinois							7 miles. Undeveloped, unlicensed.
• New Site No. 2, Lake County, Illinois							10 miles. Undeveloped, unlicensed.
• Airport Site, Lake County, Illinois							9 miles. Undeveloped, unlicensed.
• Environmental Services, Incorporated, Boise, Idaho							About 1,500 air miles. Licensed to receive PCBs. Rail transportation available.

PD998.058.7

Table 2-1 (page 8 of 8)

LIST OF UNIT PROCESSES FOR REMEDIAL ACTION ALTERNATIVES
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Alternative	Slip No. 3	Upper Harbor	North Ditch and Parking Lot Area: North Ditch	North Ditch and Parking Lot Area: Oval Lagoon	North Ditch and Parking Lot Area: Crescent Ditch	North Ditch and Parking Lot Area: Parking Lot	Comments
Incineration							Would be paying for transportation and incineration (001, 002, 005).
TRANSPORTATION							
Train	X	X	X	X	X	X	Railroad tracks nearby.
Barge	X	X	X	X	X	X	Applicable for three sites (002).
Truck	X	X	X	X	X	X	Applicable for all sites (002).

FD990.058.8

Because of the estimated large mass of uncontained PCBs and their persistence in the environment, the potential for adverse impacts would remain high for many years (005, 001). The advantage of the No Action alternative is that it would not require an immediate capital expenditure under CERCLA. The No Action alternative was retained for further evaluation during initial screening.

IN-PLACE DESTRUCTION

Ultraviolet/Ozonolysis

The joint application of ultraviolet (UV) radiation and ozone leads to significant oxidation of chlorinated hydrocarbons. However, no attempts have been made to characterize end-products or their toxicity. The reliance on UV radiation limits the oxidation action to exposed surfaces. UV radiation would not penetrate deep sediment deposits. The technology was designed for use in a closed system rather than in-place (005, 057). UV/ozonolysis has been eliminated from further evaluation because of its limited effectiveness in mitigating the PCB problem due to deep penetration of PCB contamination in soils and sediments.

Biodegradation

Biodegradation involves the use of biological agents (e.g., microbes, worms) to transform PCBs to nontoxic residues. The agent must:

- Be site-selected to match the environment
- Be able to disperse throughout all contaminated layers at all depths in both aerobic and anaerobic environments
- Not be harmful within the food chain
- Be able to consume all types of PCBs present, including highly chlorinated ones
- Not adversely disturb the existing ecology of the area

To date, problems with in-place application and viability in an uncontrolled environment have not been resolved (001, 005); therefore, biodegradation has been eliminated from further evaluation.

Chemical Oxidation

Chemical methods developed for in-place destruction of PCBs have not been promising. One process is limited to the destruction of PCB-contaminated oils or liquids and is not adaptable to detoxification of solids in aqueous materials. Another process is limited to destruction of PCB liquids and is not applicable to contaminated dredge sediment slurry or in-place use. PCBs can be extracted from contaminated dredge sediment slurry using an organic solvent, but not in very large volumes and not in-place. Most strong oxidizing agents have significant environmental impacts of their own and have never been used in an open, aquatic environment (001, 005). Chemical oxidation has been eliminated from further evaluation because it is not technically feasible at this time.

Radiation (Gamma and Electron Beam)

Both gamma and electron beam radiation are capable of a stepwise breakdown in the molecular structure of complex organics. Sufficient doses of gamma radiation can carbonize organic compounds, leaving no trace of the parent compound. Electron beams produce a similar degradation of organic compounds at lower energy levels. PCB levels were significantly reduced in studies that used radiation to disinfect municipal sewage sludge. Byproducts and their toxicity have not been investigated. No attempt has been made to test these approaches in-place (005). Radiation has been eliminated from further evaluation because it is not technically feasible for in-place application at this time.

IN-PLACE FIXATION

Sorbents

Sorbents are absorbent materials employed to treat contamination resulting from soluble chemicals. It has been suggested that these materials may be used to reduce desorption from sediments by partitioning the contaminant between available physical and chemical phases. At equilibrium, PCB concentrations in each phase would have a constant ratio. Some sorbents may reduce the availability of the contaminant in the natural system because PCBs have a stronger affinity to the sorbent than the sediment, which would then reduce the ambient levels of PCBs. Large-scale experiments to prove effectiveness have not yet taken place. Furthermore, some areas are so highly contaminated that, even with a reduction in availability of several orders of magnitude, contamination levels would remain high (005). Sorbent fixation has been eliminated from further evaluation because it may not be effective in reducing PCB concentrations to levels below 50 ppm.

In-place Stabilization

This process involves pumping a mixture of portland cement and proprietary reagents into the contaminated sediments. This is done at many points, until the sediment bed becomes a series of vertical columns stacked side by side. The mixture solidifies and traps sediment particles in an insoluble silicon hydroxide matrix (001, 005). The process is similar to grouting. There is no way of knowing how deep or how thoroughly the stabilizing agents penetrate.

In Slip No. 3 and the Upper Harbor area, not only would complete stabilization be difficult, but maintenance dredging would require special dredging techniques to avoid equipment damage from the hardened surface of the stabilized sediments. Long-term stability of the treated sediments is not yet known. The process was first used in Japan in 1973.

In the North Ditch/Parking Lot area, the stabilized sediments would be rigid enough to serve as a foundation for construction projects, but it would be difficult to ensure that all the PCBs were stabilized because of the inaccuracies of the mixing process and variabilty in the depth of contamination. This process is significantly more expensive than containing and capping with slurry walls. For the above reasons, in-place stabilization has been eliminated from further evaluation.

Impermeable Membrane Seal

Placement of an impermeable membrane over contaminated sediments in the harbor would immobilize contaminants by blocking interchange of sediments and interstitial water with the water column. Impermeable membranes have a finite life in the environment, however, which makes this technique a temporary process. Breakdown is accelerated by such physical forces as debris, strong currents, severe ice, dredging activities, boat anchors, etc. It would also be necessary to vent the seal to allow for escape of gases formed in the sediments as a result of anaerobic biological activity. This venting would compromise the purpose of the film (005). Therefore, sealing with an impermeable membrane has been eliminated from further evaluation.

IN-PLACE PCB SEPARATION AND REMOVAL

Retrievable Sorbents

Retrievable sorbents (see sorbents for definition) have the ability to concentrate contaminants from water and sediments, then be collected and removed. Some sorbents are rendered retrievable by the incorporation of magnetic particles into the media matrix, which can then be collected with magnetic devices. However, as discussed above for in-place fixation using sorbents, some areas are so highly contaminated that, even with a reduction of several orders of magnitude, the contamination levels would remain high. Large-scale equipment has not been developed for field implementation (005). Retrievable sorbents have been eliminated from further evaluation because they may not be effective at reducing PCB concentrations to levels below 50 ppm.

Bioharvesting

This process uses the ability of aquatic species to accumulate contaminants in their tissues. The species are placed in the contaminated environment, then harvested and disposed of in a suitable manner. This process is similar to the treatment of sewage sludge by water hyacinths.

This is a slow process, however. Harvestable aquatic life takes up PCBs from water. At the OMC site, PCB contamination resides largely in sediments. Translocation of PCBs from soils into plant life has not been observed. Consequently, PCBs cannot be removed without desorption from sediments and solution in the water column. Large-scale equipment for harvesting has not been developed for field implementation (005). Bioharvesting has been eliminated from further evaluation because it is not technically feasible.

Oil-soaked Mats

This approach is similar in concept to the retrievable sorbents in that it relies on the application of a medium that has a higher affinity for the contaminant than the natural system and is in a form that is readily retrievable. Technology for this process is conceptual and not available for field implementation (005). Oil-soaked mats have been eliminated from further evaluation because the method is not technically feasible.

Solvent Extraction

Solvent extraction is conceptually like retrievable sorbents. A lighter-than-water solvent with a high affinity for PCBs would be mixed with contaminated sediments. PCBs would desorb and enter the solvent phase, which would then rise to the surface to be collected and removed. Many of the best solvents are toxic, however, and nontoxic solvents could leave toxic residues. Questions of efficiency, turbidity associated with mixing of sediments, and accumulation of solvent by organic sediments must be addressed before field implementation of this process could take place (005).

The Franklin Institute's proprietary process of using mineral oil to extract PCBs from sediments is still in the developmental stage. Mineral oil is mixed with the PCB-contaminated sediments. The oil is retrieved when it floats to the water surface. PCB removal efficiencies demonstrated in the laboratory with thorough mixing of a PCB-contaminated sediment do not appear to be sufficient to reduce the levels of PCB contamination below 50 ppm. Pilot scale testing to determine efficiencies of the process in-place could delay the project. Senior research engineer David Kyllonen, Franklin Institute, provided projected costs for method development and in-place extraction of PCBs from Slip No. 3 and the Upper Harbor. The cost is estimated at $35 million (063). Solvent extraction has been eliminated from further evaluation.

PCB-CONTAMINATED SOLIDS REMOVAL

Freezing Before Removal

This process, used in the tunneling field, relies on the presence of water-bearing permeable soils. Refrigeration probes are placed in the sediments at close intervals and cooled from a portable refrigeration unit. Ice crystals grow until they coalesce, forming a wall of frozen sediment that can be lifted out with little disturbance to the remaining sediment. The process is extremely slow, however, because each probe can only freeze a zone about 1½ ft in diameter. This process is not suitable for field implementation because of the size of the contaminated area. The process is also not cost-effective because of the high energy requirements to freeze large volumes. Therefore, freezing before removal has been eliminated from further evaluation.

Mechanical Dredges

Mechanical dredges remove sediments and dump them onto an adjacent barge. The sediments must be removed from the barge and hauled to the disposal site or placed into a receiving basin for dewatering of sediment slurry. It may be possible to fix (chemically bind the free water; see FIXATION) dredged sediments without dewatering. Some mechanical dredges create a high degree of sediment suspension. Therefore, they require installation of a form of sediment dispersal control and removal of additional soluble PCBs from the ambient water after completion of dredging. Another disadvantage of mechanical dredges is that placement and depth of cut are somewhat difficult to control, thereby impacting removal efficiencies.

Mechanical dredges would be impractical for removal of soils and sediments in the North Ditch/Parking Lot area because dewatering the area before excavation would be more cost-effective than dewatering the dredged soils.

Clamshell. A clamshell dredge uses a bi-parting bucket that is lowered to pick up sediments and raised by a hoisting cable. The bucket then dumps its contents onto an adjacent barge or possibly into a hopper on the dredge barge. An estimated 15 to 30 percent of the muck sediments may be spilled back into the harbor during raising of a concentional clamshell bucket, and, in deeper water, losses up to 50 percent may occur (001). PCB removal efficiency is therefore reduced. Problems with the clamshell dredge are that it excavates only the sediments directly below the bucket, to a poorly controllable depth. The exact location of the excavation is also poorly controllable. The next excavation may not be directly adjacent to the first, but may leave a ridge of contaminated sediments between the two. An average production rate is 150 cubic yards per hour (yd^3/hr) (005). An advantage of the clamshell dredge is that it may be possible to fix dredged sediments without dewatering.

A watertight clamshell would reduce losses in the upper water column as the loaded clamshell moves through the water. However, sediment suspension within 5 ft of the bottom is greater with use of a watertight clamshell compared with an open clamshell, although suspended sediments nearer the bottom will settle out quickly (055).

The clamshell dredge was retained for further evaluation during initial screening.

Dragline. A dragline dredge throws the bucket ahead of the dredge barge, then draws the bucket through the sediment back toward the barge. The bucket is then raised to the surface and emptied onto an adjacent barge. An average production rate is 125 yd^3/hr (005). This type of dredge needs a wide maneuvering space for operation. It also creates a high degree of sediment suspension. Therefore, the dragline dredge has been eliminated from further evaluation.

Dipper. A dipper uses an articulated arm to scoop sediment into a bucket that is then raised out of the water and swung around to a barge, over which the bottom of the bucket is opened. An average production rate is 100 yd^3/hr (005). The digging action is more violent than that of other mechanical dredges, causing more severe sediment dispersion. Therefore, the dipper dredge has been eliminated from further evaluation.

Bucket Ladder. This method uses a continuous line of buckets cycling over a frame that is lowered to the bottom at an angle. Each bucket digs into the bottom and transports its contents to the surface in a continual motion, bucket after bucket. At the surface, the dredged material is transferred to a conveyor or chute, which loads the sediments onto a receiving barge. This type of dredge would have the most adverse impacts on water quality by dispersing contaminants over a wide range. Because the bucket ladder dredge is becoming obsolete in the United States (005), it has been eliminated from further evaluation.

Sauerman. To use a Sauerman dredge, a crane is positioned on one side of the harbor, supporting a vertical tower. From the top of the tower, an overhead cable slopes downward to a deadman on the opposite side of the harbor. The dredge bucket is a horseshoe-shaped scraper that is suspended from a pulley assembly that runs on the overhead cable. When the bucket is released from the crane, it and the pulley assembly move across the harbor by gravity. The crane operator can drop the bucket in the harbor at any desired distance from the crane. The bucket is attached to a tagline from the crane and is pulled toward the crane. This piles the sediment on the bottom of the harbor, where a clamshell dredge or other equipment can lift it out of the harbor. This type of dredge severely disturbs the bottom sediments and creates a high degree of sediment suspension. Therefore, the Sauerman dredge has been eliminated from further evaluation.

Hydraulic Dredges

Hydraulic dredges use a suction line, a centrifugal pump, and a discharge line to remove sediments. The discharge line normally rests on a series of pontoon floats and can be extended to any desired length with the aid of booster pumps. The dredge pump discharge provides for "built-in" transport of the dredged materials over limited distances without the need for booster pumps. Average pump production rates range from 2,000 to 4,000 gallons per minute (gpm), with a solids production rate of between 100 and 200 yd^3/hr (005). Hydraulic dredges require water to mix with sediments to form a slurry that can be pumped. The sediment slurry (about 10 percent solids) would be piped to a receiving basin for dewatering of sediment slurry. The slurry water must then be removed from the sediments and treated. Hydraulic dredges create a low to medium degree of sediment suspension, but they still require installation of a form of sediment dispersal control.

Hydraulic dredges would be impractical for removal of soils and sediments in the North Ditch/Parking Lot area because dewatering the area before excavation would be more cost effective than dewatering the dredged soils.

Hopper Dredge. This ship-shaped vessel is self-contained and self-propelled. It uses an onboard suction pump to draw sediments through a suction head and pipe into the vessel, where it fills large hopper compartments. When full, the vessel proceeds to a specially prepared location, connects to a discharge, and pumps the water-laden sediment slurry to an on-land disposal site. This dredge requires extensive maneuvering space, which the harbor area does not have (005). Therefore, the hopper dredge has been eliminated from further evaluation.

Cutterhead Pipeline Suction. This dredge uses tugs for general positioning, then uses widespread anchors to winch forward. The cutterhead rotates to loosen hard sediment and to direct the sediments into the suction intake. The cutterhead is equipped with a shroud that partially covers the cutter mechanism to lessen sediment dispersion. Sediment dispersion may be reduced by removing the cutterhead; however, this would only allow removal of loose, unconsolidated materials. Floating pontoons support the discharge line, which can vary from 6 to 42 inches in diameter. This type of hydraulic dredge cuts a trench in the bottom sediments. The use of anchors and tugs for dredge movement can have an adverse impact on water quality around the suction intake (001, 005). The cutterhead dredge was retained for further evaluation during initial screening.

Dustpan. This is a self-propelled dredge whose suction head is shaped like a large dustpan. Water jets are mounted along the leading edge of the intake to scarify hard sediments. The suction head and line are mounted on a frame positioned in a well section that is located in the forward part of the dredge. Precise control over the depth of dredging is provided by winch cables. Under normal conditions, the dustpan head is capable of cutting a swath of up to 36 ft wide with a controlled depth. The dustpan dredge head is capable of removing only loosely consolidated materials. The sediments are pumped through a discharge line from 800 to 1,000 ft long to a disposal site (001, 005). The existing dustpan dredges are located on the lower Mississippi River and are engaged in constant maintenance activity. The dustpan dredge was eliminated from further evaluation because one would probably not be available for use.

Mudcat. This dredge is not self-propelled, so movement is gained by winching to an object onbank or to deadman anchors. The dredge uses a horizontal screw auger mounted on the end of a hydraulically operated boom. The auger is designed as two halves that operate in opposite directions, feeding sediments to a central suction head. A shield can be hydraulically lowered over the augers to minimize turbidity and entrap sediments. The dredge has the capability to go to a depth of 10 to 15 ft while cutting an 8-ft swath on the bottom. The discharge line floats on the water surface and transports the sediment to a disposal site (005). Because almost all of the PCB-contaminated sediments are deeper than the Mudcat dredge can penetrate, it has been eliminated from further evaluation.

Sidecaster. This type of dredge operates in the same manner as the hopper dredge, except that the dredged material is cast overboard from either side of the vessel, by a boom with a 180-degree swing radius. Sidecaster dredges are not adaptable to contaminated sediments (005). Therefore, the sidecaster dredge has been eliminated from further evaluation.

Pneumatic Dredges

Pneumatic dredges remove sediments and transport them in a discharge pipeline to a receiving basin for dewatering of sediment slurry. Often, less water is conveyed with the sediments by using a pneumatic rather than a hydraulic dredge. Ideally, 40 percent solids could be pumped. Therefore, it may be possible to fix the dredged materials without dewatering the slurry. They create a low degree of sediment suspension but still require installation of a form of sediment dispersal control. The operation of the pneumatic dredge may create some volatilization of PCBs into the atmosphere.

Pneumatic dredges would be impractical for removal of soils and sediments in the North Ditch/Parking Lot area because dewatering the area before excavation would be more cost-effective than dewatering the dredged soils.

Airlift. The airlift dredge works by injecting compressed air near the bottom of a partially submerged vertical-recovery pipe positioned close to the bottom. This process causes a high-velocity flow into the submerged base of the recovery pipe, near the sediments, because of the density reduction in the upper pipe section and the hydraulic head of the water outside the pipe. The bottom sediments are transported through the pipe to the surface, where the sediment slurry is discharged into a recovery barge. Most of the sediments raised from the bottom are drawn into the recovery pipe, minimizing turbidity. The airlift dredge is not self-propelled and excavates only the sediments directly below the recovery pipe; however, these units function well in deep waters (005). The airlift dredge is generally fabricated for a specific purpose, and is not commonly available equipment; therefore, it has been eliminated from further evaluation.

Pneuma. The Pneuma dredge operates on the same principle as the airlift dredge. The system operates using static water head and compressed air to collect and carry sediments into the dredging head. Compressed air is used to empty the sediments from the dredging head into the discharge line. Several dredging heads operating in offset sequence combine for continuous pumping (005). An average production rate for the Pneuma is 400 to 500 yd^3/hr. The Pneuma dredge was retained for further evaluation during initial screening.

Namtech. The Namtech dredge operates on the same principle as the airlift dredge. This dredge is currently being tested under USEPA approval. Ideally, this dredge may pump at 40 percent solids, which would minimize dewatering and/or fixation requirements. More information should be available in early August 1983. The Namtech dredge has been eliminated from further evaluation at this time because of insufficent information.

Oozer. This Japanese unit combines the principles of vacuum and water pressure with a variety of suction head designs for various sediments. The USCOE views the Oozer as effective in controlling turbidity, and they speak highly of its capabilities. At this time, no Oozers are operational in the United States (005). An average production rate for the Oozer is 130 yd^3/hr. The Oozer dredge was retained for further evaluation during initial screening.

Excavation Equipment

The term "excavation" is used in this FS to mean removal of contaminated soils using various types of tracked or wheeled equipment. The degree to which water can be excluded from the area of removal determines the type of excavation equipment to be used. Common equipment used in excavation creates dust and noise and requires decontamination.

Temporary support of excavations may be required for deep excavations or for excavations near structures. Excavations could permit volatilization of PCBs.

Excavation of the harbor sediments has been eliminated because it would require sealing off and dewatering the harbor. The potential for failure of the existing sheet piling is too great to consider excavation for Slip No. 3 and the Upper Harbor.

Scraper. A scraper is a combination excavating and hauling unit. Scrapers may be towed or self-propelled. The scraper cuts a relatively thin layer of soil (i.e., 3 to 6 inches) that is collected within the scraper body. Materials can be hauled any distance onsite, then deposited in thin lifts at the disposal site. Scrapers generally operate on a relatively dry soil surface. They are not suitable for deep, localized excavation and, therefore, have been eliminated from further evaluation.

Front End Loader. A front end loader is an excavating device that operates on a relatively dry soil surface. Front end loaders pick up a desired amount of material in a front-mounted bucket, and dump it into trucks or at a selected disposal area. Typical production rates for truck loading are 200 to 300 yd^3/hr. Front end loaders were retained for further evaluation for removal of fixed solids from curing cells (storage areas for fixation processes) and for excavation from the North Ditch/Parking Lot area.

Backhoe. A backhoe is a self-propelled device that normally operates from a stationary position at the side of the excavation. Backhoes excavate materials with a bucket, normally at depths of up to 30 ft and distances of up to 25 ft. The bucket dumps the materials into trucks. Typical production rates for truck loading are 200 to 300 yd^3/hr. Backhoes are suitable for excavation of wet soils. Backhoes were retained for further evaluation for removal of solids from the initial solids dewatering basins (basins used to dewater dredged solids) and from the North Ditch/Parking Lot area.

Dragline Crane. A dragline crane operates from a stationary position at the side of the excavation. Draglines excavate materials with a bucket attached to a cable system, normally at depths of up to 30 ft and distances of up to 100 ft. The bucket can be cast some distance beyond the end of the crane boom. It is then pulled toward the crane by a tagline, and soil is loaded into the bucket through an open front. The bucket dumps the materials onto stockpiles or into trucks. An average production rate is 75 yd^3/hr, and a dragline is suitable for use on wet soils. Dragline cranes were retained for further evaluation for removal of solids from the initial solids dewatering basins.

SEDIMENT DISPERSAL CONTROL

Dredging operations create some degree of sediment suspension as a result of operating the dredge head. Therefore, during removal of contaminated sediments, turbidity and sediment dispersal must be controlled to prevent the spread of contamination and subsequent degradation of water quality (005, 001).

Single Silt Curtain

Silt curtains consist of filter fabric suspended from floats. They are not watertight membranes. They are stretched in a line, defining the location to be dredged. A single curtain flexes or bends in response to waves, boat wakes, or other water disturbances. This may allow water to splash over the top or rip the curtain (001). Single silt curtains have been eliminated from further evaluation because they would not provide adquate containment.

Double Silt Curtain

A double silt curtain is two flexible silt curtains in parallel, with a buffer space between them to catch any spillover. It is more effective than a single silt curtain. Turbidity in the buffer space may be flocculated by use of a cationic polymer (001). Double silt curtains were retained for further evaluation during initial screening.

Water-inflated Dam

A water-inflated dam is an ellipsoidal-shaped (egg-shaped) dam constructed from reinforced urethane rubber. It is installed at a site by securing the ends to steel piles or deadmen onshore, and weighting the bottom of the dam to rest on the harbor bottom. This would require some disturbance of the sediments under the dam to provide a tight seal. This type of dam can withstand a difference in water elevation of several feet (001). Water-inflated dams are specialized items, normally custom-fabricated for a particular application. They are generally not cost-effective. Therefore, a water-inflated dam has been eliminated from further evaluation.

Sheet Piling

Steel sheet piling could also be used for sediment dispersal control. Sheet piles alone are not watertight. To minimize movement of water and sediment outside the piling, a lower water level would be maintained inside the piling. This would require pumping and treatment of harbor water. This type of system would reduce migration of PCBs dissolved in the water (by dredging activity) across the barrier because water would tend to flow into the contained area through all openings in the sheet pile barrier. Sheet piles were retained for further evaluation during initial screening.

SURFACE WATER AND GROUNDWATER CONTROL

Cofferdam

The penetration of PCBs is apparently too deep in some areas to permit PCB removal without supporting the excavation to protect existing facilities. The deep contaminated sediments would be excavated with dredging equipment, such as a clamshell (001). Before the deep sediments could be excavated, the surface water (e.g., harbor water) would have to be controlled. A cofferdam could be built to control surface water inflow. The water within the cofferdam limits would be pumped through the water treatment system to maintain a lower water level inside the cofferdam. A localized cofferdam in Slip No. 3 to remove the deep contaminated sand and silt was retained for further evaluation during initial screening.

Dewatering

Open-cut excavation would require some groundwater control. Applicable dewatering techniques include using sheet piles or slurry walls to control groundwater inflow, and well points and pumping to remove groundwater. Well points and pumping can be used alone when structural support of excavations is not required. Soils and sediments would then be excavated with conventional excavation equipment. Dewatering techniques for the North Ditch/Parking Lot area and the localized area in Slip No. 3 were retained for further evaluation during initial screening.

Injection of Grout

Grouts consist of liquids or suspensions that may be injected into the ground and that subsequently harden. They fill soil voids and bind soil particles together to form an impermeable mass. In essence, they can be used to form in-place cofferdams around and under the site. It is not possible to fully evaluate the grout's effectiveness for reducing groundwater flow. This is because it is very difficult to determine where the injected material flows to since it will take the path of least resistance. It is generally impossible to be sure that no "windows" in the grouted zone remain ungrouted. The method also would not be cost-effective. Injection of grout has been eliminated from further evaluation because it is neither technically viable nor cost-effective.

Sheet Piles

Steel sheet piles would be installed down to the glacial till layer to control the movement of groundwater. However, they would leak at the interlocks. For economy, they are usually removed after excavating, if possible. Sheet piles were retained for further evaluation for control of groundwater inflow in the North Ditch/Parking Lot area. Sheet piles with bracing can provide temporary support of structures during excavation and dewatering. Sheet piles with bracing were retained for further evaluation for structural support of the North Ditch and Crescent Ditch.

Slurry Walls

Slurry walls would be constructed by excavating a trench down to the glacial till layer. During excavation, the trench would be kept filled with a slurry mixture to prevent movement of groundwater and trench collapse. After excavation, soil would be placed in the trench and mixed with the slurry to form a low-permeability zone. Slurry walls are relatively impervious, with typical permeabilities of about 10^{-7} centimeters per second (cm/sec). Slurry walls were retained for further evaluation for control of groundwater flow in the North Ditch/Parking Lot area.

BYPASS

A bypass diverting surface water flow around the highly contaminated portions of the North Ditch would eliminate further contamination of Lake Michigan by PCB-laden sediments eroded from the North Ditch. The erosion results from essentially noncontaminated sources of water (e.g., stormwater, cooling water) flowing through contaminated portions of the ditch. The bypass would collect all surface water that now runs into the North Ditch and direct it to Lake Michigan by the shortest feasible route without contacting PCBs. This could be accomplished with underground pipe or an impervious lined open ditch. This would have to be done before the North Ditch could be excavated.

Grading

The North Ditch/Parking Lot area would be regraded to direct surface flow away from the North Ditch. This would reduce but not eliminated the amount of surface water available to erode contaminated sediments from the North Ditch. The contaminated sediments could thus still be transported to Lake Michigan. Therefore, grading of the North Ditch/Parking Lot area without a pipeline or ditch has been eliminated from further evaluation.

Pipeline

A gravity pipeline bypass could be constructed to divert surface water flow around the highly contaminated areas of the Crescent Ditch and Oval Lagoon. This bypass would collect drainage from the 36-inch-diameter storm sewer (that flows north at the west edge of OMC's property), the OMC property roof drains, and regraded areas north and south of the Crescent Ditch. This bypass would be a gravity pipeline discharging to Lake Michigan. It would be constructed along the sheet piling north of the east-west portion of the North Ditch. The Parking Lot area would be regraded to divert surface water flow to catch basins. A pipeline was retained for further evaluation during initial screening.

Lined Open Ditch

The process described above, under Pipeline, could be implemented using a lined open ditch in place of a pipeline along the east-west portion of the North Ditch. A lined open ditch was retained for further evaluation during initial screening.

Temporary Pumphouse

A temporary pumphouse could be installed to intercept flows from the storm sewer on the west side of the OMC building to prevent discharge through the Crescent Ditch. The stormwater would be pumped to Lake Michigan. A temporary pumphouse would require a number of large pumps. A full-time operator would probably be needed during construction. A temporary pumphouse has been eliminated from further evaluation because pumping is generally not cost-effective compared with gravity flow.

INITIAL SOLIDS DEWATERING

Dredging with a hydraulic or pneumatic dredge produces a slurry of water and solids. To separate the slurry water from the contaminated sediments, initial solids dewatering would be required. Solids could be dewatered by gravity and/or mechanical means.

No Dewatering

Contaminated sediment slurry would be disposed of in whatever form it was extracted, usually containing between 10 and 25 percent solids by volume. The dredged sediments must be nonflowable to be accepted at a licensed chemical waste landfill (40 CFR 761.75). Since the sediment slurry would be flowable, the only practical option for sediments greater than 500 ppm would be disposal by incineration. To minimize the energy requirements to drive off excess water, incineration would also require dewatering. Therefore, the No Dewatering alternative has been eliminated from further evaluation.

Lagoon on OMC Property

Construction of a dewatering lagoon for dewatering solids could be undertaken on a large fenced parcel owned by OMC that lies due east of Slip No. 3 (001). This area could accommodate a diked area of up to 1,200 by 800 ft using dikes above grade. A lagoon could also be constructed on vacant land west of the railroad tracks and northwest of the harbor (002). This property is 0.5 mile from the nearest harbor access. A pipeline would be required to transport dredge sediments across a public roadway, across several railroad tracks, and through private property. The OMC property is the preferred lagoon location.

Specific dimensions of the lagoon would be based on the type of dredging option selected, a minimum overflow rate to allow for 2 hours detention (004), and a minimum water height above the sediment bed for volatilization control. The lagoon would be constructed above ground because of the high groundwater table and construction debris buried in the area. The bottom and sides of the lagoon would be sealed to prevent contamination of groundwater. Supernatant would be decanted for treatment (005). A lagoon on OMC property was retained for further evaluation during initial screening.

Portable Sediment Processing System

A portable sediment processing system consists of elevated settling bins with steep-sloped sides. Elevation of the bins provides head for a bank of hydrocyclones, in which solids that are heavier than water are separated by centrifugal force. Sediment slurry then flows into a Uni-Flow bag-type filter. Pilot scale studies indicate that the system operates successfully; large-scale operations have not been undertaken (047). This system can be easily installed and removed after use.

Two clarifier bins in a USEPA demonstration project (047) each had a capacity of 36 yd^3 with 144 square feet (ft^2) of surface area. The process capacity was 1,500 gpm of slurry. Four bins could conceivably process slurry from an average dredge (dredge pump range 2,000-3,000 gpm). The settled solids could be loaded directly onto trucks by gravity flow. The number of hydrocyclones and Uni-Flow filters must be sized by the physical characteristics of the dredged sediments and the solids loading rate expected. Because of the low expected specific gravity (1.3) of some of the dredged sediments, hydrocyclones may not be effective in this application, thus producing a greater solids loading to the bag filters. This could cause excessive head loss at the filter surface and require frequent backwashing. Additional elevated bins for settling may reduce the problem. The portable sediment processing system was retained for further evaluation during initial screening.

North Ditch as Dewatering Basin

The North Ditch could conceivably act as a dewatering basin. The east-west portion of the North Ditch is estimated to be 1,800 ft long, 20 ft wide, and about 3 ft deep. If the solids settled evenly throughout the length of the ditch and the supernatant was collected over a weir at the end of the ditch, it might hold the sediments produced by 1 day of dredging operations (assuming dredge capacity of 150 yd^3/hr and solids 1 ft deep). Using the Oval Lagoon and Crescent Ditch would increase the capacity for solids removal. Initially excavating the North Ditch to increase its size would also provide additional capacity. The settled solids would be periodically removed for disposal. The North Ditch was retained for further evaluation during initial screening.

Barge Storage

Contaminated sediment slurry removed from the harbor could be pumped to barges for dewatering. The supernatant would be decanted with the use of submersible pumps, treated for contamination, and disposed of. The sediment would be removed from the barges after 2 months of dewatering (004), fixed, and disposed of. Barges were retained for further evaluation for initial solids dewatering in Slip No. 3 during initial screening. Barges have been eliminated from further evaluation for initial solids dewatering in the Upper Harbor because of the large storage volume required.

Thickening with Other Project Area Solids

Solids from other project areas that are relatively dry when excavated may be mixed with dredge slurry to produce the desired moisture content for fixation. This would minimize the degree of dewatering required for the dredged slurry. Possible sources of relatively dry excavated material are the stockpile of sand near the OMC Parking Lot from previous excavation and material above the water table that is easily accessible on the project site. Addition of other project area solids was retained for further evaluation during initial screening.

Slip No. 3 as Dewatering Basin

Slip No. 3 could be used as a dewatering basin. Sheet piling with walers around the slip would need to be installed to prevent collapse of the existing sheet piles. A cofferdam with slurry wall would need to be installed across the mouth of the slip to create a basin. Supernatant could be pumped from the surface of the slip and treated before discharge back to the harbor or to a sanitary sewer. Solids could be removed for fixation and/or disposal by a clamshell dredge. Using Slip No. 3 as a dewatering basin would not be cost-effective. Therefore, Slip No. 3 as a dewatering basin has been eliminated from further evaluation.

Dehydro Drying Beds

Dehydro drying beds assist sedimentation with the use of a permeable mat and a vacuum system to speed dewatering. A flocculant is added to the contaminated sediment slurry. The sediment slurry is then distributed over the permeable mat, and water drains through the mat. A vacuum system is activated when the volume of the sediment slurry has been reduced by half. The vacuum holds until the sediment slurry cracks, allowing air through the bed. Ninety percent of the moisture is removed with this method. The supernatant is collected in a central sump, and the sediment is then scraped off and disposed of. Loading rates are high, since evaporation is not required to achieve sludge drying (061). Dehydro drying beds have been eliminated from further evaluation because to match the capacity of the dredging equipment, they would require as much space as the lagoons. In addition, the cost of installation is greater, and the solids would have to be removed daily.

Gravity Thickener

A gravity thickener resembles a conventional circular clarifier, except that it has a greater bottom slope. A predetermined hydraulic loading rate is obtained before contaminated sediment slurry is added to the thickener. The sediment slurry enters at the center of the thickener and the solids settle into a blanket at the bottom. The sediment slurry is agitated gently to dislodge trapped gas, prevent bridging of the solids, and keep the sediment slurry moving toward the center removal well. The supernatant passes over a weir at the outer margin of the thickener (062). Typical harbor sediments have a specific gravity greater than the design specific gravity for the unit and, therefore, may cause torque overload. In addition, the removal of solids from the thickener using conventional pumping equipment would result in operational difficulties. Because the use of a gravity thickener would not be cost-effective due to high capital cost, gravity thickeners have been eliminated from further evaluation.

SECONDARY SOLIDS DEWATERING

The secondary solids from the water treatment plant would consist mostly of chemical floc. The concentration of solids taken from the sedimentation tanks would be approximately 2 to 3 percent. To dewater these solids, either a belt filter press could be used, which would bring the solids concentration up to about 40 percent, or the solids could be returned to the dewatering basins and treated with other solids.

Mechanical Dewatering/Belt Press

Mechanical dewatering with the use of belt pressure filters has been employed in wastewater treatment plants in the United States since 1971. This process requires a fairly homogeneous size of material in order to reduce damage to the belt and equipment (062). Removal of large and small objects would be required before the belt press could be used in order to have a homogeneous mixture to process. Mechanical dewatering was retained for further evaluation during initial screening.

Air Dry and Treat with Other Solids

The secondary solids removed in the water treatment process could be collected in the sedimentation basin. After all water treatment is completed and the basin drained, the solids could be air dried and treated with the other solids. Treating with other area solids was retained for further evaluation during initial screening.

FIXATION

Fixation is a chemical process that binds, hydrates, or otherwise removes free water. Chemical fixation of sludges and soils has proven effective for many classes of hazardous waste (089). Fixing agents such as portland cement, pozzolan, flyash, lime, sodium silicate (005), and/or certain polymers such as Locksorb (051) are mixed or injected into the sludge or soil. The material becomes like concrete or a loose aggregate.

Fixation could eliminate the need for extensive initial solids dewatering if the water content is not excessive. The advantage to fixing relatively dry excavated material is ease of transporting to obtain a nonflowable consistency within the "given" time frame. Train, barge, or truck could be used to transport the solids. The disadvantage of this alternative is the added cost of the fixing agent and of transporting and disposing of the extra volume. Fixation was retained for further evaluation during initial screening.

WATER TREATMENT

A limit of 1 ppb PCB concentration in water discharges has been set by USEPA (00[illegible]). Therefore, a water treatment system is necessary to treat contaminated water that results from the cleanup operation. The contaminated water would include:

- Slurry water from dredging harbor sediments
- Water used to flush slurry lines
- Groundwater removed during area dewatering
- Rainwater and leachate (if a lagoon is used)
- Water used to clean equipment

No Water Treatment

Contaminated water would not be treated but disposed of either with the solids or alone in an appropriate containment vessel. A very large volume of water would have to be contained, which would be less cost-effective than treating the water. Therefore, the No Water Treatment alternative has been eliminated from further evaluation.

Flocculation/Sedimentation

Flocculation/sedimentation involves the addition of a coagulant material (i.e., alum or certain cationic polymers) to coagulate and settle colloids out of solution (001, 005). The water to be treated would contain PCB-contaminated solids that need to be removed. Flocculation/sedimentation was retained for further evaluation during initial screening.

Filtration

Contaminated water could be filtered to remove essentially all suspended solids. Flocculation/sedimentation would be required before filtration to reduce blinding of the filter surface. Filtration is based on the entrapment of contaminated solids too small for removal by sedimentation (001, 005). Filtration was retained for further evaluation during initial screening.

Carbon Adsorption

Adsorption is the result of interactions between the sorbate and the surface of the sorbent. Carbon particles have an extensive surface area that attracts and holds hydrophobic organic materials. Carbon is highly effective in removing the soluble fraction of PCBs to below discharge limits (less than 1.0 ppb) (004, 005, 037). Sedimentation and filtration are necessary prerequisites to prevent blinding of the carbon surface. Carbon adsorption was retained for further evaluation during initial screening.

Klensorb

Klensorb is an alternative to activated carbon (056) and can use the same hardware as carbon adsorption. It may be more cost-effective in removing those organics that are difficult for activated carbon (i.e., oil) (056). Since PCBs are oily, oils may pass through the filtration process and blind the carbon surface. However, at this time, laboratory tests have shown that activated carbon can meet discharge requirements (004) on Waukegan Harbor slurry water, but no laboratory tests have been conducted to confirm the effectiveness of Klensorb. This alternative would require laboratory scale testing to determine the effectiveness of the technology, as well as its cost-effectiveness. Klensorb will not be considered for further evaluation at this time because activated carbon has been shown to be effective. If, however, the activated carbon should fail because of the oily nature of PCBs, Klensorb should be reconsidered.

Ultraviolet/Ozonolysis

See IN-PLACE DESTRUCTION, earlier in this section, for a description of the UV/ozonolysis technique. This process works well with liquid streams because large quantities of PCBs can be removed. It requires a large surface area and a thin water film to be effective (005, 057). Destruction efficiencies are approximately 95 percent. UV/ozonolysis has been eliminated from further evaluation because it may not be effective in reducing PCBs below 1 ppb.

Catalytic Reduction

Catalytic reduction of PCBs using a copper-iron catalyst is in the conceptual stage. Reduction of the chlorine functional groups on PCBs would result in a hydrocarbon skeleton, which would be susceptible to biochemical oxidation. However, it is unclear whether reduction of PCBs really takes place or whether the apparent product is a result of retention on the catalytic column (005). Catalytic reduction has been eliminated from further evaluation because it is still in the conceptual stages of development.

Wet Oxidation

This process oxidizes organic materials underwater by the addition of pressurized oxygen and elevated temperatures. Organic materials are converted predominantly to carbon dioxide, releasing energy in the form of high-pressure steam. Steam can then be recovered for operation of the process with about 80 percent efficiency (059). Wet oxidation has been eliminated from further evaluation because of excessive energy requirements, and because it would not be cost-effective in this application.

High-Efficiency Boilers

High-efficiency boilers can be used to decontaminate liquids having PCB concentrations between 50 and 500 ppm. This method of thermal destruction is very efficient, reducing PCB concentrations to 0.0 ppm (057). High-efficiency boilers have been eliminated from further evaluation because they have high energy requirements and are not cost-effective in this application.

Chlorinolysis

This established technology converts chlorinated hydrocarbons to carbon tetrachloride. The technique involves the addition of chlorine under high pressure and low temperatures without the use of a catalyst. Other molecules may be produced, depending on the purity of the starting liquid. Chlorinolysis has not been specifically applied to PCB contaminants (057). Chlorinolysis has been eliminated from further evaluation because unknown byproducts may be produced.

The Goodyear Process

This process involves the addition of sodium naphthalide to the PCB-contaminated liquid. The reagent removes chlorines from PCB molecules and forms sodium chloride (NaCl) and nonhalogenated polyphenyls rapidly at room temperature. The Goodyear process appears to work well on Aroclors in the 50 to 500 ppm range. Large-scale development has not been developed for field implementation (057). The Goodyear process has been eliminated from further evaluation because it is not readily available and has not been field tested.

The Sunohio Process

Sunohio has developed a process called PCBX, which breaks PCBs in transformer oil down into their primary components of biphenyl and chlorine. This process appears to be able to handle a wide variety of PCB-contaminated fluids and a wide range of concentration. Field equipment is available (057). The Sunohio process has been eliminated from further evaluation because use of the process has been limited to treatment of transformer oils, not sediment-laden aqueous streams containing PCBs.

Use of North Shore Sanitary District Wastewater Treatment Facility

Contaminated waters could be taken to the North Shore Sanitary District wastewater treatment plant, but treatment for PCB removal is not currently available at the plant. Because the North Shore facility is currently in use, it is unavailable and therefore, has been eliminated from further evaluation.

ONSITE STORAGE/DISPOSAL

Disposal of dredged materials that contain PCBs is regulated by 40 CFR 761.60(5). The three disposal options available are: (1) in an incinerator that complies with 40 CFR 761.70, (2) in a chemical waste landfill that complies with 40 CFR 761.75, or (3) upon application, using a disposal method approved by the USEPA Regional Administrator.

Only two options are available for disposal of soils that contain PCBs, as regulated by 40 CFR 761.60(4): (1) in an incinerator that complies with 40 CFR 761.70, or (2) in a chemical waste landfill that complies with 40 CFR 761.75.

CERCLA 101(24) (PL 96-510) defines remedial action to include, but not be limited to, "such actions at the location of the release as storage, confinement, perimeter protection using dikes, trenches or ditches, clay cover...dredging or excavation...collection of leachate and runoff...and any monitoring reasonably required to assure that such actions protect the public health and welfare and the environment."

If the PCBs could be removed from the dredged material before disposal, the large quantity of sediments would not need the USEPA Regional Administrator's approval for disposal.

Landfill

A permanent storage facility could be constructed under the OMC Parking Lot area south of the North Ditch. The facility would have to meet USEPA and IEPA requirements for an Annex II landfill unless a waiver is obtained from the Regional Administrator (40 CFR 761). The landfill would be large enough to store 224,300 yd^3 of contaminated materials with 25 percent excess capacity. A slurry wall would be constructed around the perimeter down to the glacial till layer. This would allow for dewatering during construction.

The facility would be lined with 5 to 10 ft of compacted clay. After filling, it would be capped with 3 ft of compacted clay and resurfaced for use as a parking lot. A leachate collection system, embedded in gravel and sandwiched in the clay liner, would lead to manholes for pumpout. Groundwater monitoring wells would be installed around the facility to measure background water quality (001). Construction of a secure landfill at the Parking Lot would involve a number of technical and environmental problems. Since much of the soil under the Parking Lot is contaminated, it would have to be removed and stored during liner construction, then later replaced in the fill. Large quantities of liner materials would have to be imported. Because of the large quantity of material to be disposed of, the completed landfill would have to extend above existing grade. The landfill would remain partially below the water table, and extremely close to Lake Michigan. These conditions do not meet 40 CFR 761.75 requirements and would necessitate obtaining a waiver. Even if waivers were obtained, this alternative would be less cost-effective than containment/encapsulation. For these reasons, a landfill (as described above) on OMC property has been eliminated from further evaluation.

Containment/Encapsulation

Containment/encapsulation, to mitigate the environmental effects from uncontained PCBs, would involve sealing off the contaminated area. Slip No. 3 and the Oval Lagoon area would be filled in with other PCB-contaminated sediments or soils. The contaminated sediments would be capped with 3 ft of compacted clay, and covered with a synthetic liner (impermeable membrane, concrete, or asphalt) to an elevation above the 100-yr flood plain. A slurry wall would be constructed around the containment area down to the glacial till layer. Groundwater monitoring wells would be installed around the containment area to measure background water quality (001). This method would require the Regional Administrator's approval and would have to meet the requirements set forth in 40 CFR 761.60 and 40 CFR 761.75. Containment/encapsulation was retained for further evaluation for Slip No. 3 and the North Ditch/Parking Lot area.

PCB Extraction

Pollution Science International is developing a process of PCB extraction (089, 090) under a USEPA-approved research and development project now in progress. This process entails extracting PCBs from sediments, disposing of the sediments locally, and sending the concentrated PCBs to a licensed chemical waste landfill or incinerator. The main concern is process economics. The equipment is reported to be a nonconventional use of conventional and available equipment. The process needs to be demonstrated under this nonconventional application. Because of a lack of available information, extraction has been eliminated from further consideration at this time. When more information becomes available (expected in mid-October or November), this alternative should be considered in conjunction with containment/encapsulation.

Chemical Destruction

Most processes for destruction of PCBs by chemical treatment have been demonstrated with liquids only. A few conceptual processes may be applicable for solids. The microwave plasma method, developed by Lockheed, destroys PCBs by a 15-kilowatt microwave plasma reaction, and yields products of carbon dioxide, water, and potentially hazardous products of carbon monoxide and organochlorines. The process may be able to destroy PCB concentrations between 50 and 500 ppm effectively, but further research is required (057). The gamma and electron beam radiation technique, described under IN-PLACE DESTRUCTION (earlier in this section), may be effective for destruction of PCBs in sediments and soils in conjunction with containment/encapsulation (005). However, chemical destruction has been eliminated from further evaluation because it is still in the developmental stages.

Biological Breakdown

Biological breakdown in conjunction with containment/encapsulation was considered. All biological disposal methods are based on the ability of microorganisms to break down toxic materials. There are many problems associated with biological degradation, such as:

- Most systems need to remain aerobic.
- Biological degradation rates are temperature dependent.
- Complete contact with the toxic material must be made (usually very time-consuming).
- The biologically active material must be disposed of.

More research is needed in this area to make it a viable solution (057, 005, 001). Therefore, biological breakdown has been eliminated from further evaluation.

Incineration and Landfill Ash

A mobile field incinerator could be used onsite to destroy contaminated sediments and soils. Residues may weigh between 50 and 85 percent by weight of the original material, and could be used as fill elsewhere onsite. The incinerator used for PCB destruction must meet the requirements of 40 CFR 761.70, which states that incineration of PCB-contaminated sediment slurry must be brought about by maintaining a temperature of 1,200 degrees centigrade (°C) with a 2-second retention time in the secondary combustion unit and 3 percent excess oxygen in the stack gas, or by maintaining a temperature of 1,600°C with a 1.5-second retention time in the secondary combustion unit and 2 percent excess oxygen in the stack gas. Both must have a combustion efficiency of 99.9 percent or greater. USEPA and IEPA monitoring requirements must also be met. Onsite incineration was retained for further evaluation during initial screening.

Water Disposal

Treated water with PCB concentrations less than 1 ppb would be conveyed back to the harbor or to a sanitary sewer for disposal. All waters would be sufficiently treated to reach the required discharge level for PCB concentration. Water disposal was retained for further evaluation during initial screening.

OFFSITE STORAGE/DISPOSAL

Three disposal options are available for dredged materials that contain PCBs (40 CFR 761.60) are: (1) in an incinerator that complies with 40 CFR 761.70, (2) in a chemical waste landfill that complies with 40 CFR 761.75, or (3) upon application, using a disposal method approved by the Regional Administrator.

For PCB-contaminated soil, only two options are available: (1) in an incinerator that complies with 40 CFR 761.70, or (2) in a chemical waste landfill that complies with 40 CFR 761.75 unless a waiver from these requirements is obtained.

The definition of remedial action does not include offsite storage/disposal "unless the President determines that such actions (A) are more cost-effective than other remedial actions, (B) will create new capacity to manage...hazardous substances in addition to those located at the affected facility, or (C) are necessary to protect public health or welfare or the environment from a present or potential risk which may be created by further exposure to the continued presence of such substances or materials" (CERCLA 101(24)(PL 96-510)).

Landfill

Contaminated solids could be taken to a licensed chemical waste landfill site for long-term storage/disposal. Landfilling does not destroy the contaminant but contains it from further degrading the environment. Offsite landfill sites that were retained for further evaluation during initial screening are listed below:

SCA Chemical Waste Services--Model City, New York. This facility is licensed to receive PCBs but is more than 500 miles from the OMC site. There is barge service to the site.

Clermont Environmental Reclamation--Williamsburg, Ohio. This facility is licensed to receive PCBs but is more than 350 miles from the OMC site. This site has a USEPA waiver from depth to groundwater requirements (40 CFR 761) (034). Truck service is provided to the site. CECOS was recently bought by Browning Ferris Industries but shall be referred to in this report as CECOS.

Chemical Waste Management--Calumet City, Illinois. This facility is not licensed to receive PCBs. It is in an industrial area with rail access 75 miles from the OMC site. Appropriate state and Federal permits would have to be secured.

Browning Ferris Industries--Lake County, Illinois. This facility, 13 miles from the OMC site, is not licensed to receive PCBs. It is in a rural setting, and 28 buildings (mostly residences) are within a 0.5-mile radius of the facility. This facility would require a USEPA waiver from depth to groundwater requirements (40 CFR 761) (034).

New Site No. 1--Lake County, Illinois. This potential landfill site, 7 miles from the OMC site, is in a rural setting with commercial, industrial, and residential uses within a 2-mile radius (002).

New Site No. 2--Lake County, Illinois. This potential landfill site, 10 miles from the OMC area, is in a rural/industrial setting, with 38 structures located within a 0.5-mile radius. Four housing developments, along with commercial, institutional, and industrial uses, all lie within a 2-mile radius (002).

Airport Site--Lake County, Illinois. This potential landfill site, approximately 5 miles from the OMC site, is in an industrial setting. The Port of Waukegan has suggested the availability of property near the Waukegan airport as a possible landfill site.

Environmental Services, Incorporated--Boise, Idaho. This facility is licensed to receive PCBs, but is about 1,500 miles from the OMC site. There is rail service to within 31 miles of the site.

Incineration

See ONSITE STORAGE/DISPOSAL, earlier in this section, for a description of this technique. Contaminated sediment slurry would have to be transported to an approved incinerator. Transporting, rehandling, and storage requirements for incinerating offsite render this option economically infeasible. Offsite incineration has been eliminated from further consideration.

TRANSPORTATION

There are three possible means of transporting PCB-contaminated materials to offsite disposal: truck, barge, and train. These transportation modes were all retained for further evaluation during initial screening.

Section 3
RECOMMENDED ALTERNATIVES FOR INITIAL SCREENING

The unit processes retained for further screening were assembled into alternative remedial action systems for initial screening. Figures 3-1 through 3-5 present the alternatives considered for each area. The following paragraphs describe these flow diagrams.

SLIP NO. 3

Alternative 1: Dredge-Fix-Dispose

A sediment dispersal control device, consisting of a double silt curtain or sheet piling, would be installed across the mouth of Slip No. 3. Sediments in excess of 50 ppm PCBs would be removed with a mechanical dredge and placed in trucks for transport to an onsite batch plant. Sediments could also be removed with a pneumatic dredge and the sediment slurry pumped through a pipeline to the batch plant.

A mechanical dredge would be used to dredge the area of deep contaminated sand and silt near the OMC outfall. This deep dredging would be performed inside a cofferdam. The water level inside the cofferdam would be kept lower than outside to cause water flow toward the contained area. The removed water would be routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the harbor or to a sanitary sewer. Sediments could be thickened by adding other project area solids to minimize fixing agent addition. The sediment would then be fixed at the batch plant by adding portland cement, Locksorb, or another fixing agent to hydrate the excess water. The mix would be transported to curing cells. The fixed solids would be cured until they were nonflowable. This is expected to take about 1 day. The fixed solids would then be removed from the curing cells by front end loaders for transportation by truck, train, or barge to an approved disposal site.

Alternative 2: Dredge-Dewater-Fix-Dispose

For this alternative, a sediment dispersal control device as described for Alternative 1 would be installed across the mouth of Slip No. 3. Sediments in excess of 50 ppm PCBs would be removed with a hydraulic dredge and the sediment slurry pumped through a pipeline to the initial solids dewatering basin. Dredging of the deep contaminated sand and silt would be performed as described for Alternative 1. Solids would be dewatered using one of the following types of initial solids dewatering basins:

- Solids dewatering in the east-west portion of the North Ditch would require solids removal after one 8-hour day of dredging and 16 hours of settling. Solids would then be removed by backhoe, loaded into trucks, and transported to the batch plant.

- A clay-lined dewatering lagoon would be constructed on OMC property for solids dewatering. Solids and 1 ft of the clay liner would be removed by dragline 2 months after dredging activities were completed, loaded into trucks, and transported to the batch plant.

- Solids dewatering would be effected in bins/cyclones/filters and solids removed after one 8-hour day of dredging and 16 hours of settling. The solids would be loaded into trucks and transported to the batch plant.

- Dredged sediments would be placed in barges to dewater the solids. Solids would be removed by a backhoe or dragline about 2 months after dredging activities were completed and loaded into trucks for transport to the batch plant.

In all the above initial solids dewatering basins, the supernatant would be continuously decanted and routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the harbor or to a sanitary sewer.

The dewatered solids could be thickened with other project area solids. They would be fixed as described for Alternative 1 to render solids to a nonflowable form, and transported by truck, train, or barge to an approved disposal site.

Alternative 3: Dredge-Dewater-Dispose

A sediment dispersal control device as described for Alternative 1 would be installed across the mouth of Slip No. 3. Sediments in excess of 50 ppm PCBs would be removed with a hydraulic or pneumatic dredge, and the sediment slurry pumped through a pipeline to the initial solids dewatering basin. Dredging of the deep contaminated sand and silt would be performed as described for Alternative 1. All solids would be dewatered using one of the initial solids dewatering basins described for Alternative 2. For this alternative, however, they would be dewatered to the degree necessary to reach a nonflowable condition. In general, this would require more time and/or more equipment. The solids would then be transported by truck to an approved disposal site. The supernatant would be continuously decanted and routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged back to the harbor or to a sanitary sewer.

Alternative 4: Dredge-Dewater-Incinerate-Dispose

A sediment dispersal control device as described for Alternative 1 would be installed across the mouth of Slip No. 3. Sediments in excess of 50 ppm PCBs would be removed with a hydraulic or pneumatic dredge, and the sediment slurry pumped through a pipeline to an initial solids dewatering basin. Dredging of the deep contaminated sand and silt would be performed as described for Alternative 1. All solids would be dewatered, using one of the initial solids dewatering basins described for Alternative 2, to a nonflowable condition. The supernatant would be continuously decanted and routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged back to the harbor or to a sanitary sewer. The solids would then be removed with a backhoe or dragline and placed in trucks to be transported to an onsite incinerator. The solids would be incinerated in an approved unit and the ash disposed of onsite.

Alternative 5: No Action

The No Action alternative will leave PCB concentrations in excess of 500 ppm in Slip No. 3 sediments and PCB concentrations in excess of 10,000 ppm in the localized area near the former OMC outfall. This alternative will not resolve the problem of uncontained toxic waste as regulated under 40 CFR 761.

UPPER HARBOR

Alternative 1: Dredge-Fix-Dispose

This alternative is the same as Slip No. 3--Alternative 1, except that dredging of deep contaminated sand and silt is not required and the sediment dispersal control device would be installed at the south end of the Upper Harbor.

Alternative 2: Dredge-Dewater-Fix-Dispose

This alternative is essentially the same as Slip No. 3--Alternative 2, except that dredging of deep contaminated sand and silt is not required; the sediment dispersal control device would be installed at the south end of the Upper Harbor; and barge dewatering could not be used because of the large storage volume required.

Alternative 3: Dredge-Dewater-Dispose

This alternative is essentially the same as Slip No. 3--Alternative 3, except that dredging of deep contaminated sand and silt is not required; the sediment dispersal control device would be installed at the south end of the Upper Harbor; and barge dewatering could not be used because of the large storage volume required.

Alternative 4: Dredge-Dewater-Incinerate-Dispose

This alternative is essentially the same as Slip No. 3--Alternative 4, except that dredging of deep contaminated sand and silt is not required; the sediment dispersal control device could be installed at the south end of the Upper Harbor; and barge dewatering could not be used because of the large storage volume required.

Alternative 5: No Action

The No Action alternative will leave PCB concentrations between 50 and 500 ppm in the Upper Harbor. This alternative will not resolve the problem of uncontained toxic waste as regulated under 40 CFR 761.

SLIP NO. 3 AND UPPER HARBOR

Alternative 6: Contain-Dredge-Cap

A sediment dispersal control device, consisting of a double silt curtain or sheet piling, would be installed and then a permanent cofferdam would be constructed. The sediment dispersal control device and the cofferdam would be located at one of the following areas:

- To allow for dredging of all Upper Harbor sediments, the sediment dispersal control device would be installed at the south end of the Upper Harbor, and the cofferdam would be constructed near the north end of the Upper Harbor.

- To allow for dredging of the most contaminated Upper Harbor sediments, the sediment dispersal control device would be installed at the middle of the Upper Harbor, and the cofferdam would be constructed near the east end of Slip No. 3.

A slurry wall extending into the glacial till would be constructed inside the cofferdam and around the entire perimeter of the containment area.

Dredged sediments from the Upper Harbor would be placed within the contained area. Supernatant would be continuously decanted and routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the harbor or to a sanitary sewer. After dredging is completed, a layer of filter fabric, a 1-ft-thick layer of sand with a drainage system, and a 3-ft-thick compacted clay cap would cover the dredged muck. Five feet of fill over the clay would serve as a surcharge to speed up densification of the sediments. Water collected from the drainage system would be treated as described above. Slip No. 3 would be left permanently filled. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

After completion of all dredging activities, the water treatment plant would be removed and a new basin would be constructed to replace Slip No. 3. After settlement of the muck in Slip No. 3, the surcharge would be removed and the area paved.

NORTH DITCH AREA

Alternative 1: Excavate-Dispose

A bypass would be constructed to divert surface water flow around the highly contaminated areas of the Crescent Ditch and Oval Lagoon. The bypass would outfall directly into Lake Michigan. Construction would then begin on a structural slurry wall (or other structural support system) around the Crescent Ditch and a nonstructural slurry wall around the Oval Lagoon. The soils would be dewatered using well points and pumps. Well water would be routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the harbor or to a sanitary sewer.

Soils in excess of 50 ppm PCBs would be excavated by backhoe and placed in lined trucks for transport to an approved disposal site. The excavated areas would be backfilled.

Alternative 2: Excavate-Incinerate-Dispose

A bypass would be constructed as described for Alternative 1. The excavation area would be dewatered within a slurry wall, and the well water would be treated as described for Alternative 1. Soils in excess of 50 ppm PCBs would be excavated by backhoe and placed in trucks to be transported to an onsite incinerator. Excavated soils would be incinerated in an approved unit, and resulting ash would be disposed of onsite.

Alternative 3: Excavate-Fix-Dispose

A bypass would be constructed as described for Alternative 1. The excavation area would be dewatered within a slurry wall, and the well water would be treated as described for Alternative 1. Soils in excess of 50 ppm PCBs would be excavated with a backhoe and placed in trucks to be transported to the batch plant. The soil would then be fixed with portland cement, Locksorb, or another fixing agent to hydrate the excess water. The treated soil would then be transported to the curing cells. The fixed solids would be cured until they were nonflowable and then removed from the curing cells by front end loaders for transport by truck, train, or barge to an approved disposal site.

Alternative 4: Excavate-Contain-Cap

A bypass would be constructed to divert surface water flow around the highly contaminated areas of the Crescent Ditch and Oval Lagoon. The bypass would outfall directly into Lake Michigan. The east-west portion of the North Ditch would be excavated to one of the following extents:

- All of the PCB-contaminated soils in the North Ditch would be excavated to allow for construction of a bypass pipeline or a lined open ditch. This would require support of the excavated area with sheet piles.

- All of the PCB-contaminated soils in the North Ditch required to install a bypass pipeline would be excavated. This would not require support of the excavated area with sheet piles.

A nonstructural slurry wall extending down into the underlying glacial till would be constructed around the Crescent Ditch and Oval Lagoon to control movement of contaminated materials. Excavated soils from the east-west portion of the North Ditch and the Crescent Ditch area would be dewatered and placed in the Oval Lagoon area. The well water would be treated as described for Alternative 1. The site would be capped with a 3-ft-thick compacted clay layer to seal in the contaminated soils. The Crescent Ditch area would then be paved and the Oval Lagoon area seeded. This would raise the elevation of the Oval Lagoon area by 20 to 25 feet. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

Alternative 5: No Action

The No Action alternative will leave PCB concentrations in excess of 10,000 ppm in the localized areas of the Crescent Ditch and Oval Lagoon and PCB concentrations between 50 and 10,000 ppm in the soils and sediments of the rest of the North Ditch area. This alternative will not resolve the problem of uncontained toxic waste as regulated under 40 CFR 761.

PARKING LOT

Alternative 1: Excavate-Dispose

A nonstructural slurry wall would be constructed around the deep contamination in the Parking Lot area. The Parking Lot area soil would be dewatered using well points and pumps. Well water would be routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the harbor or to a sanitary sewer. Soil in excess of 50 ppm PCBs would be excavated by backhoe or front end loader and placed in lined trucks for transport to an approved disposal site. The excavated areas would be backfilled.

Alternative 2: Excavate-Incinerate-Dispose

The excavated area would be dewatered and the well water treated as described for Alternative 1. Soil in excess of 50 ppm would be excavated by backhoe or front end loader and placed in trucks to be transported to an onsite incinerator. Excavated soil would be incinerated in an approved unit, and resulting ash would be disposed of onsite.

Alternative 3: Excavate-Fix-Dispose

The excavated area would be dewatered and the well water treated as described for Alternative 1. Soils in excess of 50 ppm would be excavated with a backhoe or front end loader and placed in trucks to be transported to a batch plant. The soils would then be fixed with portland cement, Locksorb, or another fixing agent to hydrate excess water. Treated soil would then be transported to curing cells. The fixed solids would be cured until they were nonflowable and then removed from the curing cells by front end loaders for transport by truck, train, or barge to an approved disposal site.

Alternative 4: Contain-Cap

A nonstructural slurry wall extending down into the underlying glacial till would be constructed around the Parking Lot to control movement of contaminated materials. The site would be capped with a 3-ft-thick compacted clay layer to seal in the contaminated soils and then resurfaced for parking. This would raise the elevation of the site by 3 to 4 ft. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

Alternative 5: No Action

The No Action alternative will leave PCB concentrations from 50 to over 5,000 ppm in the Parking Lot area. This alternative will not resolve the problem of uncontained toxic waste as regulated under 40 CFR 761.

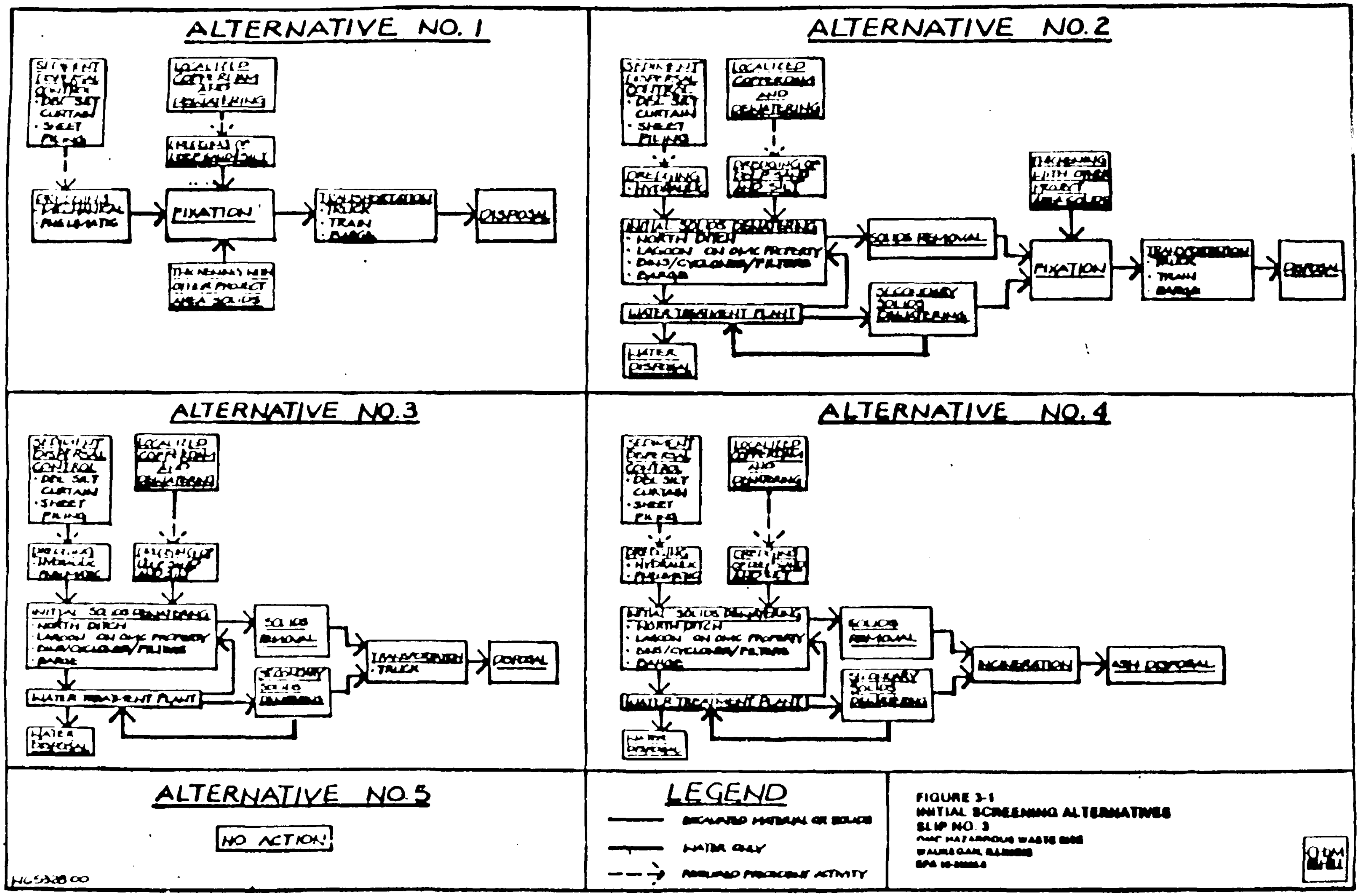


FIGURE 3-1
INITIAL SCREENING ALTERNATIVES
SLIP NO. 3

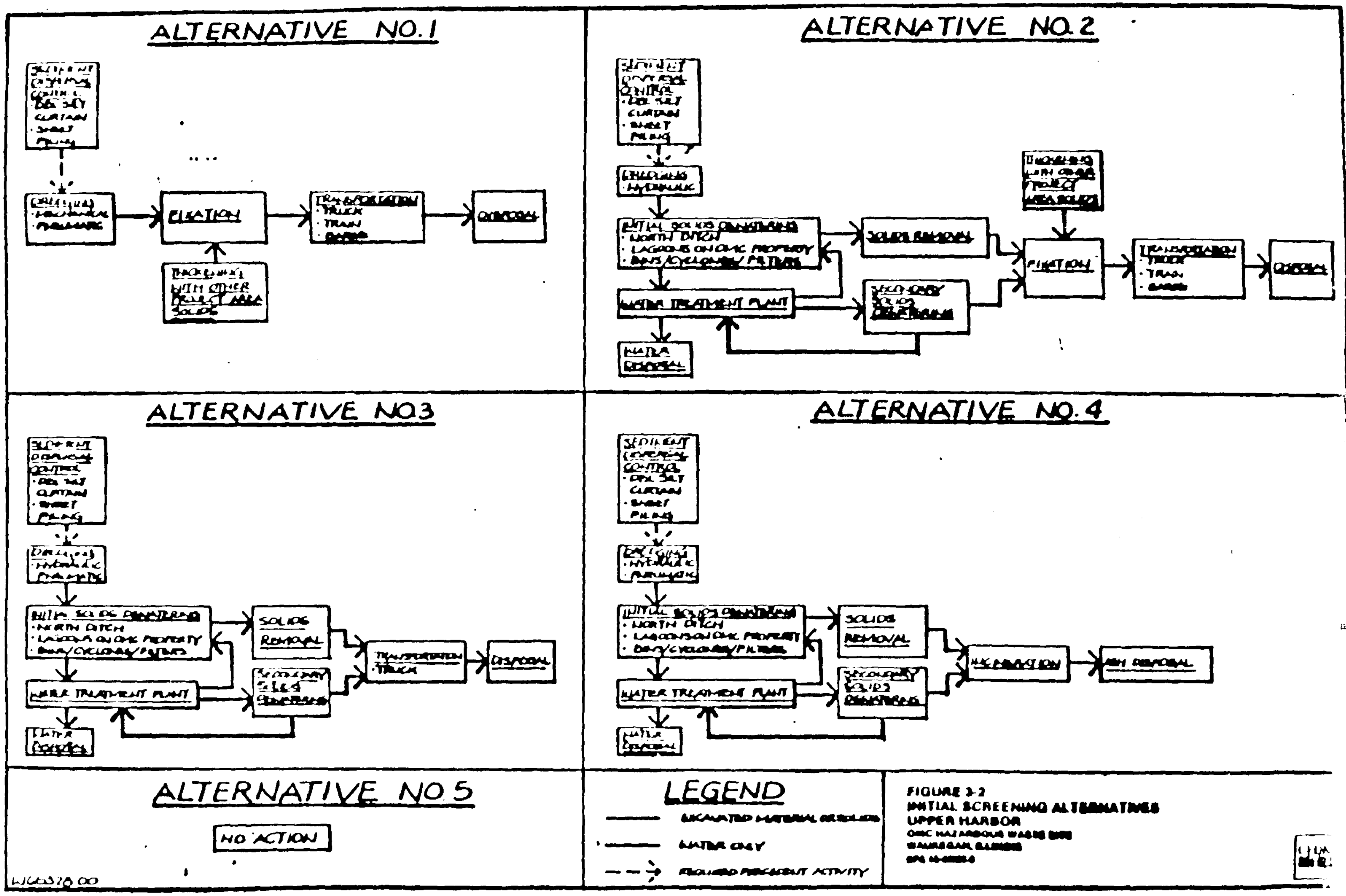
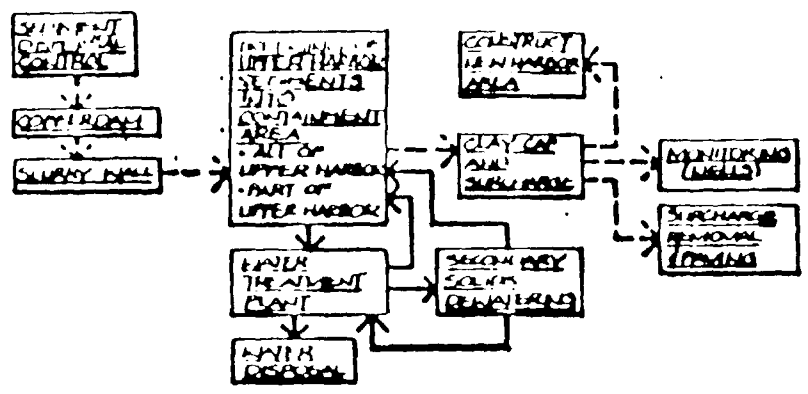


FIGURE 3-2
INITIAL SCREENING ALTERNATIVES
UPPER HARBOR
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

ALTERNATIVE NO. 6



LEGEND

— EXCAVATED MATERIALS OR SOLIDS

— WATER ONLY

- - -> REQUIRED PRECEDENT ACTIVITY

FIGURE 3-3
INITIAL SCREENING ALTERNATIVES
SLIP NO. 3 AND UPPER HARBOR
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

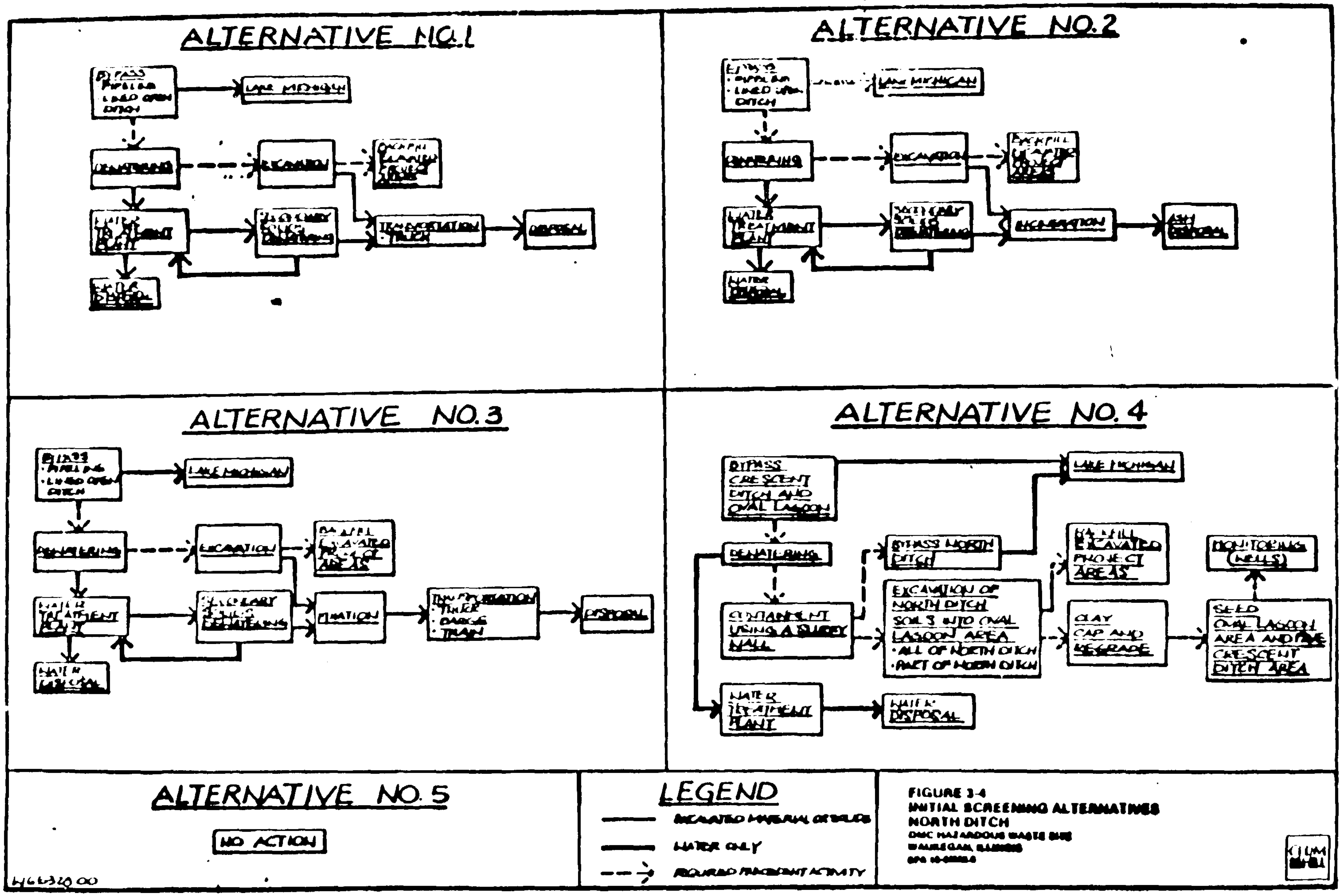


FIGURE 3-4
INITIAL SCREENING ALTERNATIVES
NORTH DITCH

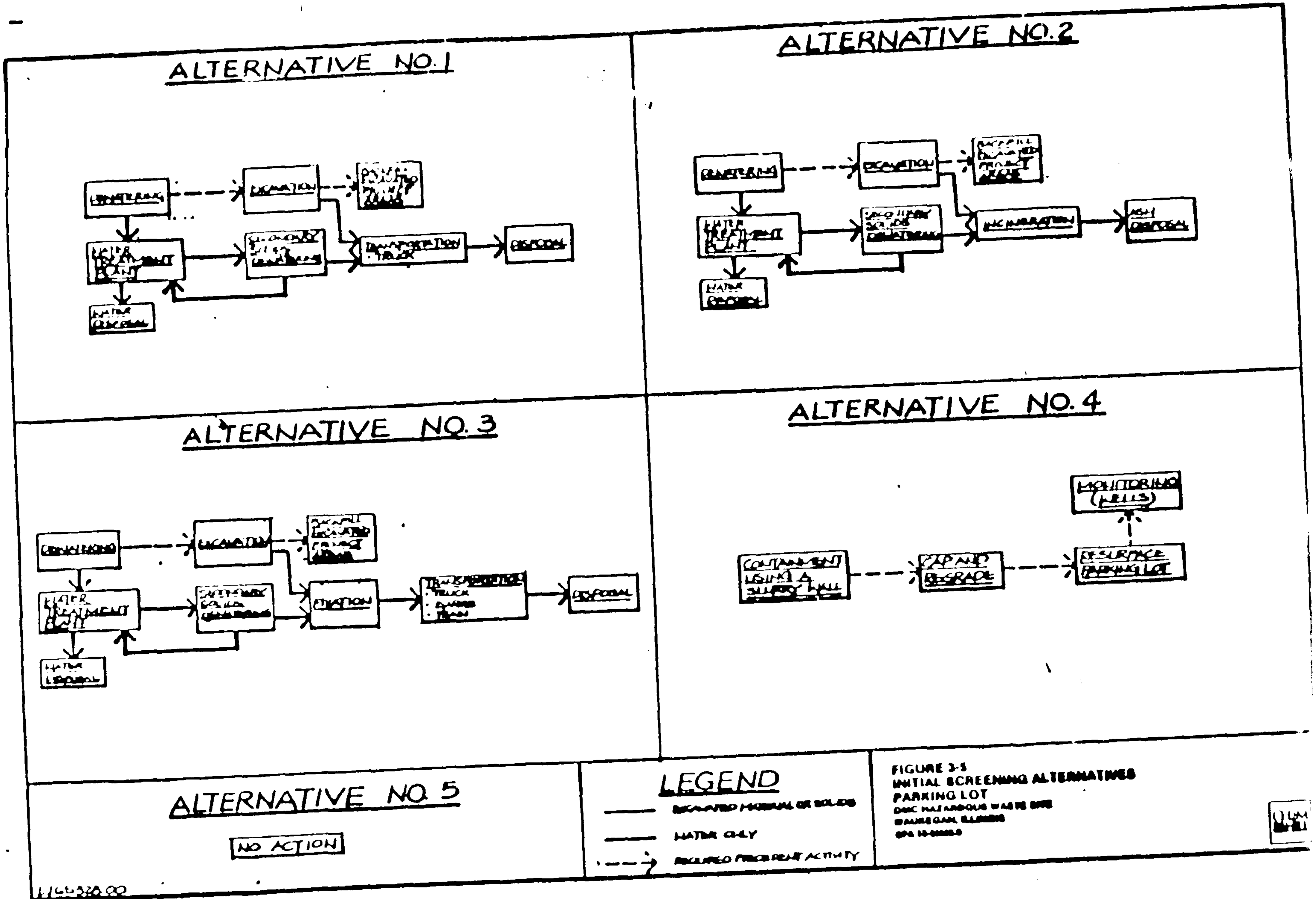


FIGURE 3-5
INITIAL SCREENING ALTERNATIVES
PARKING LOT
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

Section 4
INITIAL SCREENING

In the initial screening process, the alternatives described in Section 3 were evaluated based on engineering feasibility, estimated incremental costs, environmental effects, and in accordance with the site-specific remedial response objectives and criteria discussed in Section 1. The initial screening process narrowed the alternatives to from two to four for each area. The alternatives remaining after initial screening are discussed in more detail in Section 5.

ENGINEERING FEASIBILITY

The unit processes considered for the remedial action alternatives defined in Section 3 were further evaluated based on engineering feasibility. The criteria used to evaluate the unit processes and the justification for eliminating some additional processes are presented below. The No Action alternative is discussed later in this section under ENVIRONMENTAL EFFECTS.

Dredging

The engineering feasibility screening criteria used to further evaluate the dredging unit processes consisted of the following:

- Dredging and related activities in Slip No. 3, except in the localized area that requires dredging of deep contaminated sand and silt, should be accomplished within 2 months to reduce impacts on Larsen Marine Services.
- Dredging and related activities in the localized area of Slip No. 3 should be accomplished within 2 months. This time is in addition to the 2 months required to dredge Slip No. 3, as noted above.
- Dredging and related activities in the Upper Harbor should be accomplished within 3 months. This time is in addition to the 4 months required to dredge Slip No. 3 and the localized area.
- Dredging activities should minimize the roiling of bottom sediments.
- Dredging activities should be accomplished during nonfreezing weather unless provisions are made to store all the dredge sediment slurry.
- Dredges selected should be readily available, conventional construction equipment.

- Dredging activities must conform to applicable laws and regulations, which include (001):

  -- Clean Water Act of 1977 (PL 95-217)

  -- River and Harbor Act of 1899

  -- Illinois Rivers, Lakes, and Streams Act

In preliminary screening, all types of mechanical dredges except clamshell dredges were eliminated. Clamshell dredges were eliminated for general dredging work because bucket placement and depth of cut are difficult to control, thereby impacting the sediment removal efficiencies. Also, due to the fluid nature of the sediments, PCB-contaminated sediment could flow into the recently dredged area, reducing the PCB removal efficiency further. This could leave high concentrations of PCBs in pockets of sediment. Another disadvantage is that conventional clamshells spill 15 to 30 percent of the sediments while the clamshell bucket is being raised. This spillage creates a high degree of sediment suspension that increases the concentration of PCBs in solution.

A new watertight clamshell (055) may reduce the amount of sediments spilled by 35 percent, but it still does not have a controlled removal efficiency because of the difficulty in controlling depth and location of cut. A clamshell dredge may be used, however, in the relatively small localized area of Slip No. 3 to remove the deep contaminated sediments (sand and silt) below the muck. Dredging activities for the deep sediments would require containment within a single sheet pile cofferdam. The water would require treatment to remove dissolved PCBs before the cofferdam is removed.

The Pneuma and Oozer pneumatic dredges were retained during preliminary screening. They were eliminated during initial screening because they are not readily available in the United States, may be subject to import restrictions, and have some mechanical limitations. The Pneuma dredge used at the Cape Fear River had an estimated field production rate of 36 yd^3/hr, which is about 13 times less than the capability reported by the manufacturer (005). At that time, Pneuma North America was evaluating redesign. The Oozer dredge is not currently available in the United States and may be subject to import restrictions. Also, it has a dredging depth of only 20 ft, which is not sufficient to remove the contaminated muck layer (005).

A hydraulic dredge, cutterhead pipeline suction type, is recommended to remove the PCB-contaminated muck from Slip No. 3 and the Upper Harbor. This dredge reportedly minimizes sediment dispersion. Careful consideration must be given to selecting the proper dredge head to reduce sediment soiling and to obtain high solid-to-water ratios to minimize dewatering requirements.

Based on the above criteria, Slip No. 3--Alternative 1 and Upper Harbor--Alternative 1 have been eliminated from further consideration.

Excavation

The engineering feasibility screening criteria used to further evaluate excavation unit processes consisted of the following:

- Excavation and related activities for the North Ditch/Parking Lot area should be accomplished within 8 months.
- Excavation equipment should be commonly available, conventional construction equipment.

Based on these criteria, backhoes and front end loaders appear to be feasible for excavation during bypass construction, and for excavation of the Crescent Ditch, Oval Lagoon, and Parking Lot area. Front end loaders appear to be feasible for removal of fixed solids from fixation curing cells. Draglines and backhoes appear to be feasible for removal of settled sediments from the initial solids dewatering basins.

Sediment Dispersal Control

The engineering feasibility screening criterion used to evaluate sediment dispersal control unit processes was that they should minimize migration of dissolved PCBs across the barrier. Based on this criterion, both the double silt curtain and steel sheet piling appear to be feasible. A monitoring program to detect movement of material out of the dredging area will be enacted to warn of the need for additional control measures (shut down dredging, polymer addition, etc.).

Surface Water and Groundwater Control

The engineering feasibility screening criterion used to evaluate surface water and groundwater control unit processes was that they should reduce inflow to the excavation area. Based on this criterion, both sheet piles and structural slurry walls appear to be feasible to provide structural support and reduce inflow for the Crescent Ditch excavation and bypass construction. Nonstructural slurry walls appear to be feasible to reduce inflow at the Oval Lagoon and the Parking Lot area excavations. Dewatering with well points and pumps would be used for all areas. A single sheet-pile cofferdam appears to be feasible to reduce inflow for the Slip No. 3 localized area.

Bypass

The engineering feasibility screening criterion used to evaluate the bypass unit process was that it divert surface waters around the highly contaminated areas. Based on this criterion, both a pipeline and a lined open ditch appear to be feasible.

Initial Solids Dewatering

The engineering feasibility screening criteria used to evaluate initial solids dewatering unit processes consisted of the following:

- At least 2 hours of settling time are required before the water used to slurry the sediments can be removed for treatment in the onsite water treatment plant (004).
- Ideally, the settling time should provide sufficient dewatering of harbor sediments to obtain a moisture content that is at or below the liquid limit (nonflowable) for solids to be disposed of in a licensed chemical waste landfill.
- Six hours is the minimum settling time recommended for solids to dewater. The longer the retention time provided, the greater the solids concentration expected for the dewatered material (004). From previous experience with dewatering silts, 6 hours may not be adequate to produce a nonflowable consistency.
- The water treatment plant probably will not be protected against freezing weather. If not protected, the dewatering basins cannot release slurry water to the treatment plant during freezing conditions (001). This would require that dredging operations be conducted during nonfreezing weather.
- Under TSCA, PCB soils and sediments with concentrations greater than 50 ppm must be nonflowable if they are to be disposed of in a chemical waste landfill (40 CFR 761.75).

Based on these criteria, all the initial solids dewatering unit processes appear to be feasible. At this time, it is not possible to estimate how complete solids dewatering will be; therefore, the impact of thickening with other project area solids cannot yet be estimated. In addition, testing (under Task 4) is currently being performed on muck samples (results will be under separate cover) to determine the amount of fixing agent required to obtain a nonflowable consistency.

If the North Ditch is used for initial solids dewatering, the ditch should be modified to dewater dredged sediments from at least 1 day of dredging activity. This would require increasing the depth of the existing east-west portion of the North Ditch by about 4 ft and widening the ditch top width by about 25 to 35 ft. It should also be designed so that all groundwater flow moves toward the ditch to reduce the possibility of groundwater contamination from dredged sediments. Solids would be removed with a backhoe after settling overnight. Dredging activities would be interrupted intermittently for this operation.

If the sediments are dewatered in a lagoon constructed on OMC property or another nearby site, the lagoon would be designed to hold and dewater all the dredged sediments. The lagoon would be sized to hold 24,000 yd^3 and 128,000 yd^3 for Slip No. 3 and the Upper Harbor, respectively. Solids would be removed from the lagoon with a dragline about 2 months after dredging activities are completed. This would allow for some densification of the solids (004).

If bins/cyclones/filters are used for dewatering the dredged sediments, enough bins must be supplied to dewater sediments from 1 day of dredging activity. One hundred bins are expected to be required. Two hydrocyclones would be required. Because of the low specific gravity of the sediments, the hydrocyclones are expected to remove only a small portion of the solids. Bag filters would be used to polish the effluent prior to water treatment. The solids would be removed from the bins by gravity; it would take about 3 man-hours to empty each bin. The solids that are removed from the cyclones (mostly sand) would be loaded onto trucks to be transported to the curing cells. Solids would be removed from the bag filters by backwashing.

If barges are used to dewater the dredged sediments from Slip No. 3 only, an adequate number of barges should be provided to contain the dredged sediments and slurry water while the water is decanted. It is estimated that ten 2,000-yd^3 capacity barges would be required. Solids could be removed with a backhoe or clamshell about 2 months after dredging activities are completed.

A lagoon on OMC property or another nearby site is the only feasible initial solids dewatering unit process for the dredged sediments from Slip No. 3--Alternative 3 and Upper Harbor--Alternative 3 that might not require fixation. The North Ditch dewatering scheme and the bins/cyclones/filters were eliminated because the limited storage capacity of these unit processes would require daily removal of solids, as well as additional dewatering before the solids were dry enough for disposal in a licensed chemical waste landfill.

Barges were eliminated from Upper Harbor--Alternative 3 because harbor access would be restricted indefinitely. Additional testing is currently being performed on muck samples (results will be under separate cover) to determine the maximum solids moisture content (weight of water divided by weight of solids) that will allow disposal in a landfill, and the required retention time in a lagoon before this moisture content can be obtained. Based on experience with dredge spoils, this period could be more than 1 year and may require additional means of dewatering.

The USCOE has used vacuum underdrains and the Riverine Utility Craft (RUC) systems to dewater dredged sediments (052, 053). Tests conducted by Mason & Hanger (004) indicate that underdrain systems of sand or gravel or other media placed in the bottom of a lagoon for dewatering the dredged sediments would be relatively useless because of clogging. Therefore, the RUC system shows the most promise for dewatering the solids and was used for the purpose of cost estimating. The RUC system entails channeling the surface of the sediments to allow surface drainage of water. This water would be decanted and routed to the onsite water treatment plant. The top layer is then dried by evaporation. The dried soil (typically, the top 1 to 2 ft) would be periodically removed with a dragline. The disadvantage of this process is that evaporation, an integral part of the process, provides an escape route for PCBs to the environment via volatilization.

Secondary Solids Dewatering

Solids from the water treatment process will require treatment before disposal. A belt press was found to be less cost-effective than treating with the other area solids. Therefore, belt presses were eliminated from further consideration.

Fixation

Fixation refers to a chemical process used to bind or hydrate free water in the sediments. The engineering feasibility screening criteria used to evaluate the fixation unit process consisted of the following:

- PCB-contaminated sediments fixed with portland cement (or other fixation materials) should be transportable within 1 day.
- The fixed solids should be dry enough to be nonflowable for disposal at a licensed chemical waste landfill.

Based on the engineering feasibility screening criteria, fixation appears to be feasible. Fixation may be required if initial solids dewatering techniques cannot ensure that the PCB-contaminated sediments will be nonflowable and not lose water during transportation to the final disposal site. Fixing agents other than portland cement are being evaluated in Task 4.

Fixation requires complete dispersion of the fixing agent into the sediment to be fixed. A conventional, portable, concrete batch plant (or transit mixers for small volumes) could be used to mix the fixing agent into the sediments. Storage area would be provided onsite for curing the mixture. The quantity of fixing agent used per cubic yard can be adjusted to account for variability in the sediment characteristics and moisture contents.

Water Treatment

Laboratory tests were conducted by Mason & Hanger (004) using harbor water slurried with harbor sediments. The tests showed that sand filtration (at 3 gallons per minute per square feet) would remove suspended solids if coagulation/sedimentation were used before filtration to settle fines that could plug or pass through the filter. Coagulants found to be effective in settling the fines were both alum and Nalco #103, with 2 hours of settling after coagulant addition.

Laboratory tests on carbon filtration were also conducted by Mason & Hanger (004). Tests conducted on harbor and North Ditch samples demonstrated that carbon filtration (15-minute contact) could remove PCBs to below 1 ppb.

The water treatment system would be a "package plant" that could be easily installed and removed. The same treatment method could be used for all alternatives. These units are commonly available.

Water in Slip No. 3 and the Upper Harbor may also need treatment because dredging operations roil the sediments, which could cause increased concentrations of PCBs in solution. Treatment of the water behind the sediment dispersal control device may consist of adding one or both of the following:

- Cationic polymer to coagulate and settle the fine suspended sediments

- Activated carbon to remove soluble PCBs

Additional dredging would be required to remove the activated carbon and settled solids behind the silt curtain.

Laboratory tests conducted by Mason & Hanger (004) demonstrate that groundwater slurried with North Ditch sediments removed from the North Ditch/Parking Lot area can be treated to remove PCBs down below 1 ppb. The water treatment plant for Slip No. 3--Alternatives 2 and 3, Upper Harbor--Alternatives 2 and 3, and Slip No. 3 and Upper Harbor--Alternative 6 would be a 1,500-gpm system (assuming a hydraulic dredge operating 8 hours per day at a capacity of 3,000 gpm) consisting of coagulation, sedimentation, pressure filtration, and carbon adsorption. The treated water would be detained in a clear-well to be monitored for PCB concentration before discharge to the harbor or to a sanitary sewer. A limit of 1 ppb PCB would be maintained for discharged water. Slip No. 3--Alternative 3, Upper Harbor--Alternatives 1 and 3, and Slip No. 3 and Upper Harbor--Alternative 6 would also require a separate, smaller, water treatment plant (200 gpm) for treatment of rain-water and leachate water after the larger water treatment facility is dismantled. The water treatment plant for the North Ditch--Alternatives 1, 3, and 4 and Parking Lot--Alternatives 1 and 3 would be a 200-gpm system (assuming dewatering of sands with a permeability of 10^{-3} cm/sec) consisting of coagulation, sedimentation, pressure filtration, and carbon adsorption.

Containment/Encapsulation

The engineering feasibility screening criteria used to evaluate containment/encapsulation consisted of the following:

- TSCA regulations (40 CFR 761.60) require that applications for disposal of dredged materials that contain PCBs, other than by incineration as prescribed in 40 CFR 761.70 or in a chemical waste landfill that complies with 40 CFR 761.75, must be made in writing to the USEPA Regional Administrator. The disposal method must be based on technical, environmental, and economic considerations, indicating that disposal in an incinerator or chemical waste landfill is not reasonable and appropriate. The alternative disposal method must provide adequate protection to health and the environment (40 CFR 761.60(5)).

- CERCLA (101(24) (PL96-510) defines remedial action to include, but not be limited to, "such actions at the location of the release as storage, confinement, perimeter protection using dikes, trenches or ditches, clay cover...dredging or excavation...collection of leachate and runoff...and any monitoring reasonably required to assure that such actions protect the public health and welfare and the environment."

Containment/encapsulation of PCB-contaminated material in-place would eliminate the costs of removing and disposing of the waste. This alternative was considered for Slip No. 3 with Upper Harbor sediments used as fill, for the North Ditch area with the North Ditch soils used as fill, and for the Parking Lot area. Disposal of the PCB-contaminated soils by containment/encapsulation would require a waiver from the requirements of 40 CFR 761.75 (40 CFR 761.60(4)). Management of the site after containment would be the responsibility of the State, in accordance with CERCLA and the NCP.

Slip No. 3 and the Upper Harbor. Containment/encapsulation of Slip No. 3 would require the construction of a cofferdam and slurry wall to seal off this portion of the harbor. A slurry wall 2 ft thick would be constructed through the sandy sediments and 5 ft into the glacial till layer underlying the harbor sediments. The slurry wall would be constructed completely around the perimeter of the containment area. The water level would then be lowered in the containment area to ensure inward movement of groundwater. The water removed would be treated in an onsite water treatment system. The water would be discharged to the harbor or to a sanitary sewer. PCB-contaminated sediments from the Upper Harbor would then be transferred to the contained area. The contained area would be completely filled. Docking facilities now in Slip No. 3 would have to be relocated (021, 002). Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

North Ditch Area. Containment/encapsulation of the Crescent Ditch and Oval Lagoon would require the construction of a slurry wall 2 ft thick, extending through the sandy soils 5 ft into the underlying glacial till layer. The slurry wall would be constructed completely around the Crescent Ditch and Oval Lagoon areas. PCB-contaminated soils from the east-west portion of the North Ditch, excavated during construction of the bypass, would then be transferred, placed, and compacted on the Oval Lagoon area. The top 3 ft of the Crescent Ditch area would also be excavated and then transferred, placed, and compacted on the Oval Lagoon area. The Crescent Ditch and Oval Lagoon areas would be covered with 3 ft of compacted clay, and then the Crescent Ditch area would be resurfaced for parking and the Oval Lagoon area would be seeded. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

Parking Lot Area. Containment/encapsulation within the Parking Lot would involve construction of a slurry wall 2 ft thick, extending through the sandy soils 5 ft into the underlying glacial till layer. The area would be covered with 3 ft of compacted clay and then resurfaced for parking. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

Incineration

The engineering feasibility screening criteria used to evaluate the incineration unit process consisted of the following:

- Incinerators must be licensed to incinerate PCB-contaminated wastes before mid-1984.

- Ash with PCB concentrations of 0.0 ppm must be disposed of onsite to be cost-competitive (021).

- Based on USEPA regulations, incinerators must maintain a temperature of 1200°C (2192°F), a 2-second dwell time in the secondary combustion unit, and 3 percent excess oxygen in the stack gas; or maintain a temperature of 1600°C (2912°F), a 1.5-second dwell time in secondary combustion, and 2 percent excess oxygen in the stack gas (001).

- Based on USEPA regulations, incinerators must operate at a combustion efficiency of 99.9 percent or greater (001).

- PCB disposal should be completed by late 1986.

Incineration has been eliminated from further consideration based on the screening criteria for engineering feasibility. No major advances in incinerator technology have occurred since 1981, when USEPA reports (021 and 002) concluded that incineration was not feasible. An incinerator capable of PCB destruction under the conditions set forth by USEPA and transportable to the site has not been licensed to date. It does not appear that available technology would meet USEPA requirements without time-consuming and costly testing and permitting. Therefore, incineration is not considered a feasible alternative.

In addition to the failure of incineration to meet engineering feasibility criteria, the costs to incinerate PCB-laden sediments are expected to be on the order of 10 times greater than disposal costs. According to James Boyland (Director of Sales, SCA Chemical Wastes Services), charges to use the SCA incinerator in Chicago, Illinois, would be from 25 to 50¢ per lb of PCB-contaminated soil. The high cost of incineration is primarily due to the low heat value of the soil, requiring addition of supplementary fuel to raise the soil temperature above 2000°F. It is assumed that if an approved portable incinerator unit were available for incineration onsite (none is available at this time), the cost would be at least the same, if not more. The estimated cost for incineration at 50¢ per lb of contaminated soil approaches $1,000/yd^3$. Consequently, incineration will not be considered further. Therefore, Slip No. 3--Alternative 4, Upper Harbor--Alternative 4, North Ditch--Alternative 2, and Parking Lot--Alternative 2 have been eliminated from further consideration.

Water Disposal

The engineering feasibility criterion used to evaluate the water disposal unit process was that the water discharged have PCB concentrations less than 1 ppb. Based on this criterion, both discharging to the harbor and discharging to a sanitary sewer appear feasible.

Offsite Landfill

The engineering feasibility screening criteria used to evaluate the offsite landfill disposal options consisted of the following:

- Disposal sites must be licensed to receive PCB-contaminated wastes before mid-1984.
- Applicable laws and regulations governing disposal sites include (003):
  - -- Clean Water Act of 1977 (PL 95-217)
  - -- Toxic Substances Control Act
  - -- Resource Conservation and Recovery Act (PL 94-580)
  - -- Applicable State rules and regulations

Final site selection and evaluation for a potential hazardous waste disposal site were performed by Warzyn Engineering, Inc. (034, 040). The final report (034) evaluates the potential for offsite disposal at the Browning Ferris Industries (BFI) Lake County, Illinois, site and the Clermont Environmental Reclamation (CECOS) Williamsburg, Ohio, site. CECOS was recently purchased by BFI but shall still be referred to in this report as CECOS. Based on the engineering feasibility screening criteria, both the BFI and CECOS sites are feasible. BFI, which is only 13 miles from the OMC site, is not currently licensed to receive PCBs; however, the facility has the potential to be upgraded to meet hazardous waste landfill requirements. CECOS is licensed and ready to receive PCB-contaminated material. The CECOS site is 350 road miles from Waukegan Harbor.

Since the publication of the final site evaluation report (034), several other possibilities have been considered. Environmental Services, Incorporated (ESI), in Boise, Idaho, is licensed and ready to receive PCB-contaminated solids. The cost for disposal at ESI is comparable to the cost for disposal at CECOS. Costs for transportation to Boise, however, are expected to exceed the transportation costs to CECOS. The ESI site is about 4 times farther than CECOS. The availability of rail transport (rail station 31 miles from disposal site) is not expected to lower the transportation cost because of the many railroads affected and the difficulty in obtaining special freight tariffs, as discussed under Transportation, below.

Another site not licensed but potentially available is property owned by the Waukegan Port Authority near the Waukegan Airport.

Transportation

There are three possible modes of transporting the PCB-contaminated sediments to an offsite disposal site: trucks, barges, and railroad cars. Variables that determine the engineering feasibility of transportation modes include:

- Moisture content of the soil and/or type of fixation (e.g., block form, friable)
- Proximity of disposal site to railway access
- Proximity of disposal site to barge access
- Minimization (optimization) of waste handling or rehandling
- Time required to obtain necessary agreements/permits

If the PCB-contaminated sediments are fixed in friable (loose aggregate) form, dump trucks could be used. Railcars might still be used, but loading and unloading would be more complicated. Provisions should be made to prevent loss of fixed sediments during transportation.

If the PCB-contaminated sediments and soils are not fixed, truck transportation would be the only feasible mode of transport. The trucks would have to be lined to prevent water loss during transport.

The BFI, CECOS, and ESI disposal sites include truck transportation to their sites as part of the disposal services for their landfill operations. Rail transportation would require obtaining agreements with railroad owner(s) to transport PCB-contaminated waste. Usually, on long hauls, more than one railroad is affected. Trucking is usually more cost-effective unless a special freight tariff can be obtained from the railroads. Special freight tariffs are usually made available only to long-term users. If a hazardous waste disposal site is not adjacent to railway access, then the added cost of double handling could outweigh the possible cost savings of using rail transport.

Transportation by barge is feasible only if the final disposal site is close to the Lake Michigan Waterway access. Barges are technically feasible for transporting the toxic wastes to a disposal site near the Great Lakes Waterways (for example, SCA Chemical Wastes Services in Model City, New York). The added cost of double handling could outweigh the advantages.

Regardless of the type of transportation used, care must be taken to reduce the chance of spillage. Based on the engineering feasibility criteria, truck and barge are the only feasible transportation modes.

ESTIMATED INCREMENTAL COSTS

Comparative capital and O&M costs were evaluated for the alternatives considered feasible based on the engineering feasibility criteria. No incremental cost estimates are presented for the No Action alternative. The assumptions used to estimate incremental costs for the other alternatives are presented below.

For the incremental cost estimates, it was assumed that Level C health and safety protection equipment would be worn by all persons.

For all the incremental cost estimates except containment/encapsulation, it was assumed that PCB-contaminated sediments and soils would be taken to a licensed chemical waste landfill for disposal. An average disposal and transportation cost of $50/yd³ was assumed.

Slip No. 3

An order-of-magnitude estimate of the sediment quantities to be dredged in this area is as follows:

Slip No. 3 (muck)	7,200 yd³
Slip No. 3 (sand and silt)	3,700 yd³
Total	10,900 yd³

The rate of solids removal from Slip No. 3 was estimated to be about 200 yd³ of solids per hour or 3,000 gpm at 20 percent solids using a hydraulic dredge. Under ideal conditions, it would take five 8-hour days to dredge Slip No. 3.

Alternatives 2A, 2B, 2C, and 2D. Sediments with greater than 50 ppm PCBs would be removed with a hydraulic dredge, dewatered in an initial solids dewatering basin, fixed with cement or another fixing agent to hydrate excess water, and disposed of in a licensed chemical waste landfill.

The difference among Alternatives 2A, 2B, 2C, and 2D is the type of initial solids dewatering basin used. In each alternative, the supernatant would be continuously decanted and routed to a 1,500-gpm water treatment plant to remove suspended solids and dissolved PCBs down to 1 ppb before discharge back to the harbor or to a sanitary sewer.

Under Alternative 2A, the sediments would be dewatered in the east-west portion of the North Ditch and the solids would be removed after one 8-hour day of dredging and 16 hours of settling. A dredge production rate of 200 yd^3 of solids per hour has been used in these calculations. The required capacity of the North Ditch is estimated to be about 7,700 yd^3. This alternative would require that the dredging activity be discontinued every other day to allow for solids removal from the North Ditch. The solids would be removed by a backhoe after settling overnight. The solids would then be loaded into trucks, transported to the batch plant to be fixed, stored for 1 day for hydration in a curing cell, and disposed of in a licensed chemical waste landfill.

Under Alternative 2B, the sediments would be dewatered in a lagoon constructed on OMC property and the solids removed after completion of the dredging activities. The production of the dredge is estimated to be 200 yd^3 of solids per hour. The required capacity of the lagoon is estimated to be about 24,000 yd^3. The solids would be removed by a dragline 2 months after dredging activities are completed. The solids would then be loaded into trucks, transported to the batch plant to be fixed, stored for 1 day for hydration in a curing cell, and disposed of in a licensed chemical waste landfill. It was assumed that the upper clay liner and contaminated portions of the gravel leachate system and the bottom clay liner would be disposed of in a licensed chemical waste landfill with other contaminated solids.

Under Alternative 2C, the sediments would be dewatered in bins/cyclones/filters and the solids removed after one 8-hour day of dredging and 16 hours of settling. One hundred 36-yd^3 elevated bins, 2 hydrocyclones, and 1,250 5-inch-diameter bag filters would be required to dewater the slurry. This equipment would require use of approximately 1 acre of OMC property. The solids would be removed and fixed after settling overnight. This alternative would require that the dredging activity be discontinued every other day for solids removal from the bins. The solids could be emptied from the bins by gravity into trucks, transported to the batch plant for fixing and to the curing cells for hydration, and then transported to a licensed chemical waste landfill. Solids removal would take about 3 man-hours to empty each bin.

Under Alternative 2D, the sediments would be dewatered in barges. Approximately ten 2,000-yd^3 capacity barges would be required to dewater Slip No. 3 sediments. The solids would be removed by a backhoe or clamshell 2 months after the dredging activities were completed. The solids would then be loaded into trucks, transported to the batch plant to be fixed, stored for 1 day in a curing cell, and disposed of in a licensed chemical waste landfill.

The common denominator of Alternatives 2A, 2B, 2C, and 2D is the fixation process used to render the solids to a nonflowable consistency for disposal in a licensed chemical waste landfill. Portland cement is locally available and is an effective way to transform the dredged sediments to a nonflowable state. Dewatering and fixation testing is in progress to confirm the effectiveness of fixation using cement and other agents. Cost estimates are based on using portland cement as the fixing agent.

Assuming 250 percent moisture content (weight of water divided by weight of solids) in the sediments after 1 day of initial solids dewatering (in-place moisture content of 140 percent was assumed (042)), the in-place volume of solids is expected to be increased 50 percent by moisture content and be increased an additional 50 percent by addition of cement. Total disposal volumes used in the incremental cost estimates were increased by 100 percent for Alternatives 2A and 2C for fixed solids. The disposal volume was estimated to be 21,800 yd^3.

Assuming 140 percent moisture content in the sediments after 2 months of initial solids dewatering, the in-place volume of solids is expected to be increased by 30 percent after addition of cement. Disposal volumes used in the incremental cost estimate were increased by 30 percent for Alternatives 2B and 2D for fixed solids. The disposal volume was estimated to be 14,170 yd^3.

The cement is expected to hydrate the excess water after 1 day of curing. The 1-day storage capacity would be provided in three 125- by 75-ft, 10-ft-deep, earth-lined cells with a soil-cement bottom and concrete divider walls between cells. Dump trucks would collect the fixative/sediment mixture from the batch plant and dump it into the curing cells. It is estimated that 29 bags of cement would be required for each cubic yard of dredged sediments settled for 1 day. It is estimated that 16 bags of cement would be required for each cubic yard of dredged sediments settled for 2 months. This cement content is not expected to result in any significant structural strength. The fixed solids would be removed by front end loaders and loaded into trucks for transport to a licensed chemical waste landfill.

<u>Alternative 3. The sediments with greater than 50 ppm PCBs in Slip No. 3</u> would be removed with a hydraulic dredge, dewatered in a lagoon until the sediments reached a nonflowable consistency (possibly 1 to 2 years), and then disposed

of in a licensed chemical waste landfill. The disposal quantity was assumed to be the same as the in-place volume.

A lagoon would be constructed on OMC property or another nearby site for initial solids dewatering. This lagoon would be the same size as the lagoon for Alternative 2B. During dredging, the supernatant would be continuously decanted and routed to a 1,500-gpm water treatment plant to remove suspended solids and dissolved PCBs down to 1 ppb before discharge to the harbor or to a sanitary sewer. After dredging activities are completed, the solids would need to be dewatered for an extended time to reach the desired consistency. The surface of the pond could be channeled to provide for drainage of surface water. For purposes of cost estimating, the mechanical dewatering process was assumed to be the RUC. Air drying of the surface and periodic removal of the dry crust in multiple cycles would be performed to induce dewatering below in-place moisture contents. Leachate water and stormwater runoff would be treated in a 200-gpm water treatment plant for the duration of dewatering after the dredging is completed. The solids would be removed by a dragline and loaded into trucks for disposal in a licensed chemical waste landfill. It was assumed that the upper clay liner and the contaminated portions of the gravel leachate system and the bottom clay liner would be disposed of in a licensed chemical waste landfill with the other contaminated solids.

Summary. An Order-of-Magnitude incremental cost summary for Slip No. 3 is presented below. The alternatives are ranked in increasing order of incremental cost. The lowest cost alternative is used as the base cost. The incremental cost of each alternative above the base cost is listed below.

	Slip No. 3 Alternatives	Incremental Cost above Base Cost
3	Dredge-dewater in lagoon-dispose	Base
2D	Dredge-dewater in barges-fix-dispose	+$ 2,100,000
2B	Dredge-dewater in lagoon-fix-dispose	+$ 3,180,000
2A	Dredge-dewater in North Ditch-fix-dispose	+$ 4,780,000
2C	Dredge-dewater in bins/cyclones/filters-fix-dispose	+$11,160,000

Upper Harbor

An order-of-magnitude estimate of the sediment quantities to be dredged in this area is 35,700 yd^3. The rate of solids removal from the Upper Harbor was estimated to be about

200 yd³ of solids per hour or 3,000 gpm at 20 percent solids using a hydraulic dredge. Under ideal conditions, it would take 24 8-hour days to dredge the Upper Harbor.

Alternatives 2A, 2B, and 2C. Sediments with greater than 50 ppm PCBs would be removed with a hydraulic dredge, dewatered in an initial solids dewatering basin, fixed with portland cement or another fixing agent to hydrate excess water, and disposed of in a licensed chemical waste landfill.

The fixation process for these alternatives is the same as that described for Slip No. 3--Alternative 2. The fixed solids disposal volume at 250 percent moisture content for Alternatives 2A and 2C is estimated to be 71,400 yd³. The fixed solids disposal volume at 140 percent moisture content for Alternative 2B is assumed to be 46,400 yd³.

The initial solids dewatering basins for these alternatives are the same as those described for Slip No. 3--Alternatives 2A, 2B, 2C, and 2D, except that the lagoon capacity was estimated to be 118,000 yd³, and barges would not be used for dewatering.

Alternative 3. Sediments with greater than 50 ppm PCBs in the Upper Harbor would be removed with a hydraulic dredge, dewatered in a lagoon until the sediment reached a nonflowable consistency, and disposed of in a licensed chemical waste landfill. This alternative is the same as that described for Slip No. 3--Alternative 3, except that the lagoon capacity was estimated to be 118,000 yd³.

Summary. The alternatives for the Upper Harbor are ranked in the same manner as for Slip No. 3. The lowest cost alternative is used as the base cost. The incremental cost of each alternative above the base cost appears below.

	Upper Harbor Alternatives	Incremental Cost above Base Cost
3	Dredge-dewater in lagoon-dispose	Base
2B	Dredge-dewater in lagoon-fix-dispose	+$11,030,000
2A	Dredge-dewater in North Ditch-fix-dispose	+$11,150,000
2C	Dredge-dewater in bins/cyclones/filters-fix-dispose	+$17,780,000

Slip No. 3 and Upper Harbor

Alternative 6A. Slip No. 3 and the northwest portion of the Upper Harbor would be contained and encapsulated. A cofferdam across the north end of the Upper Harbor, consisting of an earth fill between two rows of sheet piling, would be constructed. A slurry wall would be placed in the cofferdam and completely around the perimeter of the contained area. The water would be removed and treated in a 1,500-gpm water treatment plant. About 33,500 yd³ of sediments dredged from the Upper Harbor would be placed in the contained area. The area would then be capped and paved. The surrounding area would be monitored for PCB concentration levels.

Alternative 6B. Slip No. 3 would be contained and encapsulated. A cofferdam across the east end of Slip No. 3, consisting of an earthfill between two rows of sheet piling, would be constructed. A slurry wall would be placed in the cofferdam and completely around the perimeter of the contained area. The water would be removed and treated in a 1,500-gpm water treatment plant. About 13,100 yd³ of sediments dredged from the east end of Slip No. 3 and the Upper Harbor would be placed in the contained area. The area would then be capped and paved. The surrounding area would be monitored for PCB concentration levels.

Summary. An Order-of-Magnitude incremental cost summary for Slip No. 3 and the Upper Harbor is presented below. The alternatives are ranked in the same manner as for Slip No. 3. The lowest cost alternative is used as the base cost. The incremental cost of each alternative above the base cost is listed below.

Slip No. 3 and Upper Harbor Alternatives	Incremental Cost above Base Cost
6B Contain-dredge part of Upper Harbor-cap	Base
6A Contain-dredge-cap	+$3,200,000

North Ditch/Parking Lot Area

An order-of-magnitude estimate of the soil quantities to be excavated under this alternative is as follows:

Crescent Ditch	28,900 yd³
Die storage area	2,300 yd³
Oval Lagoon	14,600 yd³
North Ditch (east-west)	25,000 yd³
Parking Lot Area	105,000 yd³
Total	175,800 yd³

The rate of solids removal from the North Ditch/Parking Lot area was estimated to be about 150 yd³ of solids per hour using a backhoe. Under ideal conditions, using one backhoe, it would take 59 8-hour days to excavate the North Ditch area and 88 8-hour days to excavate the Parking Lot area.

Alternative 1. A bypass would be constructed and soils in excess of 50 ppm PCBs would be excavated and disposed of in a licensed chemical waste landfill. The area would then be backfilled with soil. Because of the relatively high groundwater table, the area would require dewatering before excavation. Sheet piles or a structural slurry wall would be constructed to provide structural support for and reduce inflow to the Crescent Ditch excavation. A nonstructural slurry wall would be constructed to reduce inflow to the Oval Lagoon and the Parking Lot area. Dewatering with well points and pumps would be used for all areas. The groundwater removed would be treated in a 200-gpm water treatment plant before discharge to the harbor or to a sanitary sewer. This alternative assumes that the contaminated soils could be excavated in a nonflowable state and disposed of in a licensed chemical waste landfill. This is a reasonable assumption, since the North Ditch/Parking Lot area soil is mostly sand.

Alternative 3. A bypass would be constructed, and soils in excess of 50 ppm PCBs would be excavated and then fixed before disposal in a licensed chemical waste landfill. Then the area would be backfilled with soil. The excavation, dewatering, and water treatment would be the same as that described for Alternative 1. This alternative would ensure that the contaminated soils are of a nonflowable consistency, if for some reason the soils could not be sufficiently dewatered. The fixation methods would be the same as those described in Slip No. 3--Alternative 2.

Assuming 40 percent moisture content in the soils after excavation, the in-place volume of solids is expected to be increased by 25 percent after addition of cement (13 bags per yd^3). Fixed solids disposal volumes used in the incremental cost estimates were increased by 25 percent for Alternative 3. The disposal volumes were estimated to be:

North Ditch area	88,500 yd^3
Parking Lot area	131,200 yd^3
Total	219,700 yd^3

Alternative 4 (Parking Lot Area Only). This alternative consists of encapsulating the area of contamination in-place beneath the Parking Lot to minimize groundwater contamination. A slurry wall surrounding the area is assumed to be about 2 ft thick, 35 ft deep, and 2,400 ft long. The Parking Lot area would be returned to its original use after encapsulating the contaminated area, regrading, and resurfacing the area with asphalt cement paving. The surrounding area would be monitored for PCB concentration levels.

Alternative 4A (North Ditch Area Only). This alternative consists of encapsulating the area of contamination in-place beneath the Crescent Ditch and Oval Lagoon and filling above the area of the Oval Lagoon with all of the excavated PCB-contaminated soils from the east-west portion of the North Ditch and from the top 3 ft of the Crescent Ditch. A slurry wall surrounding the area is assumed to be about 2 feet thick, 35 feet deep, and 1,900 feet long. The Crescent Ditch area would be resurfaced with asphalt cement paving. The Oval Lagoon area would be seeded. The surrounding area would be monitored for PCB concentration levels.

Alternative 4B (North Ditch Area Only). This alternative is the same as Alternative 4A, except only 5,600 yd^3 of PCB-contaminated soils from the east-west portion of the North Ditch would be excavated.

Summary. An Order-of-Magnitude incremental cost summary for the North Ditch/Parking Lot area follows. The alternatives are ranked in increasing order of incremental cost. The lowest cost alternative is used as the base cost. The incremental cost of each alternative above the base cost appears below.

	North Ditch Alternatives	Incremental Cost above Base Cost
4B	Excavate-contain part of the North Ditch-cap	Base
4A	Excavate-contain-cap	+$ 4,510,000
1	Excavate-dispose	+$12,460,000
3	Excavate-fix-dispose	+$22,610,000

	Parking Lot Alternatives	Incremental Cost above Base Cost
4	Contain-cap	Base
1	Excavate-dispose	+$ 9,680,000
3	Excavate-fix-dispose	+$30,070,000

ENVIRONMENTAL CONSIDERATIONS

The following paragraphs present quantitative estimates of the amount of PCBs to be removed or contained by each alternative. The socioeconomic aspects and permit requirements are assessed. The adequacy of source control to satisfy the response objectives and to contribute substantially to protection of public health and the environment is also discussed.

Slip No. 3

Alternative 2: Dredge-Dewater-Fix-Dispose. This alternative would remove by hydraulic dredge (clamshell for the localized area of deep contaminated sand and silt) all sediments from Slip No. 3 with PCB contamination in excess of 50 ppm. Dredging activities would use a sediment dispersal control system (silt curtains or sheet piling) to minimize uncontrolled release of PCBs into the surrounding area. Because minimal volatilization is expected to occur at the dredge site (roughly 0.3 to 0.4 pound per day per acre (lb/day/acre) from an exposed, agitated, and contaminated water area (030)), only low concentrations of PCBs would be released into the air (less than 2 micrograms per cubic meter (ug/m^3)[1]) (007).

Sediments would be dewatered onsite, using (1) the North Ditch, (2) a lagoon to be constructed on OMC property, (3) bins/cyclones/filters, or (4) barges. Supernatant would be processed through a package water treatment plant. Solids from the treatment plant would be returned to be treated with the other solids. Treated water, with PCB levels below 1 ppb, would then be discharged into the harbor or to a sanitary sewer.

The greatest potential for volatilization during dewatering would occur in the North Ditch, which would require daily excavation of all the dredged solids. The excavation would stir up the sediments, causing increased volatilization. The lagoons or barges would be excavated only once, thus reducing opportunities for volatilization. The elevated bins would be decanted before the solids are removed and put through the fixation process. The contaminated sediment would not have contact with the open air for more than about 1 hour per bin-clearing operation. The highest reported concentration in a Slip No. 3 sediment sample is about 500,000 ppm PCBs (001). The predicted PCB concentration in the air from solids removal operations is predicted to be less than 200 ug/m^3 for sediments with concentrations of 100,000 ppm PCBs (007). Typical PCB concentrations range from about 50 to 5,000 ppm PCBs. Predicted average concentrations in air would be less than 6.6 ug/m^3. These values were extrapolated from data for sand assuming a 3.6-mile-per-hour (mph) wind and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

The remaining solids would be fixed in a nonflowable form to allow transport offsite without spillage. Volatilization control during transport may require use of covers. Fixed materials would be disposed of in a licensed chemical waste landfill, in compliance with State and Federal standards for PCB waste disposal.

---

[1]u=μ.

Slip No. 3 would be cleaned of all sediments in excess of 50 ppm PCBs. If a 95 percent removal efficiency were achieved, it would remove an estimated 290,000 lb of PCBs in approximately 10,900 yd^3 of sediments. This would remove about 93.5 percent of all the PCBs now found in Slip No. 3 and Upper Harbor sediments.

The most significant uncontrolled dispersal of PCBs during cleanup would result from volatilization, and is estimated to be below 1,000 ug/m^3, the OSHA standard (007).

Local land use would be temporarily impacted by the disposal, treatment, and transport operations. Upon project completion, existing local land uses could resume. A temporary impact on Larsen Marine Services would occur during the actual dredging operations. Alternatives 2A and 2C, using the North Ditch or bins/cyclones/filters, would have a greater impact on Larsen Marine Services because dredging would be interrupted every other day for solids removal.

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- National Pollutant Discharge Elimination System (NPDES) permit (State/Federal) for point-source water discharge from the water treatment plant
- IEPA permit for construction of wastewater treatment facilities
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities from Interstate Commerce Commission (ICC) and Illinois Commerce Commission (IlCC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site
- Waukegan Port Authority dredging permit

- Illinois Department of Transportation (IDOT) (Division of Waterways) permit for work in public waterways

- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

Alternative 3: Dredge-Dewater-Dispose. Like Alternative 2, this alternative would use a dredging system with sediment dispersal controls to remove all sediment with PCB contamination in excess of 50 ppm. Because minimal volatilization is expected to occur at the dredge site (roughly 0.3 to 0.4 lb/day/acre from an exposed, agitated, and contaminated water area (030)), only low concentrations of PCBs would be released into the air (less than 2 ug/m³) (007).

Dredged sediments would be dewatered by use of a lagoon on OMC property. Mason & Hanger's laboratory reports (004) and experience with dredged sediments indicate that the dredged sediments would be difficult to dewater. It was assumed that the sediments would not obtain a moisture content lower than they had in-place in the harbor without mechanical dewatering. Vacuum underdrainage techniques to densify fine-grained material have been successfully demonstrated by USCOE (053). However, laboratory tests conducted by Mason & Hanger indicate that underdrain systems of sand, gravel, or other media would be relatively ineffective for dewatering sediments from Waukegan Harbor (004).

The USCOE has used a RUC system to channel the sediments for release and drainage of water in dredged sediments. This exposes the sediments to air for evaporation and drying (052). After the top layer is dry, it is removed by a dragline and the RUC channeling process is repeated. Assuming the lagoon is 10 ft deep, the process is expected to require up to six repetitions. This would result in substantial volatilization of PCBs to the atmosphere, since evaporation is a necessary part of the dewatering process.

The highest reported concentration in a Slip No. 3 sediment sample is about 500,000 ppm (001). The predicted PCB concentration in air above sediments with concentrations of 100,000 ppm PCBs would be less than 200 ug/m³. The volatilization rate is predicted to be less than 163,000 micrograms per square meter per hour (ug/m²/hr) or 63 pounds per day (lb/day). Typical PCB concentrations range from about 50 to 5,000 ppm PCBs. Predicted average concentrations in the air would be less than 6.6 ug/m³. The average volatilization rate from these sediments is expected to be less than 5,375 ug/m²/hr or 2 lb/day PCBs. These values are extrapolated from data for sand, assuming a 3.6-mph wind and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

Supernatant would be processed through a water treatment plant. Solids from the treatment plant would be returned to be treated with the other solids. Treated water, with PCB levels below 1 ppb, would be discharged to the harbor or to a sanitary sewer.

Once the necessary drying was achieved in each layer, the sediment would be removed by a dragline and placed in trucks with seals (tailgate linings, etc.) to minimize spillage during transport. Volatilization would occur during drag-line and truck loading operations. Sediment would finally be disposed of in a licensed chemical waste landfill.

Slip No. 3 would be cleaned of all sediments with greater than 50 ppm PCBs. If a 95 percent removal efficiency were achieved, it would remove an estimated 290,000 lb of PCBs contained in approximately 10,900 yd^3 of sediments. This would remove about 93.5 percent of all the PCBs now found in Slip No. 3 and Upper Harbor sediments.

PCB releases during cleanup would be at a maximum during the evaporation phase of the dewatering operation and solids removal process. The volatilization rate of the alternative would be expected to average less than 2 lb/day, and would decrease as PCBs in the top sediments in each layer were depleted (007).

Local land use would be temporarily impacted by the disposal, treatment, and transport preparation operations. Upon project completion, existing local land uses could resume. A temporary impact on Larsen Marine Services would occur during the actual dredging operations.

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- IEPA permit for construction of wastewater treatment facilities
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits

- Local land use approval

- Certification of Authority to haul PCB commodities (ICC and IICC)

- USEPA toxic substances disposal approval

- IEPA approval if material is disposed in a currently non-PCB-approved site

- Waukegan Port Authority dredging permit

- IDOT (Division of Waterways) permit for work in public waterways

- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

Alternative 5: No Action. The No Action alternative would leave PCB concentrations in excess of 10,000 ppm in the localized area near the former OMC outfall and PCB concentrations in excess of 500 ppm in the rest of Slip No. 3 sediments. This represents an estimated 305,200 lb of PCBs in Slip No. 3 (001). PCBs in these concentrations are regulated by 40 CFR 761 under TSCA.

Without cleanup, Slip No. 3 will continue to contribute to the estimated 22 lb of PCBs (based on a steady state model) released into Lake Michigan each year from Waukegan Harbor water (035). The Waukegan area will continue to represent the most significant contributor to Lake Michigan PCB contamination, since it holds the largest known uncontained PCB mass in the lake basin. The potential for volatilization of PCBs will continue, contributing to the estimated 12 to 40 lb that are released from the harbor into the local airshed each year (007, 030).

Channel dredging has been suspended because of PCB contamination, and shipping access to the harbor will eventually be eliminated. Harbor maintenance dredging of PCB-contaminated soils is expensive because of disposal and handling requirements for sediments with PCB concentrations of 50 ppm or greater. Huron Portland Cement and National Gypsum are now and will continue to be directly impacted, since they depend on the harbor to receive raw material shipments.

Upper Harbor

Alternative 2: Dredge-Dewater-Fix-Dispose. This alternative would remove by hydraulic dredge all sediments from the Upper Harbor that have PCB concentrations in excess of 50 ppm. Dredging activities would use a sediment dispersal control system (silt curtains or sheet piling) to minimize uncontrolled release of PCBs outside the dredging area. Because minimal volatilization is expected to occur at the dredge site (roughly 0.3 to 0.4 lb/day/acre from an exposed, agitated, and contaminanted water area (030)), only low concentrations of PCBs would be released into the air (less than 2 ug/m³) (007).

- Sediments would be dewatered onsite, using (1) the North Ditch, (2) a lagoon to be constructed on OMC property, or (3) bins/cyclones/filters. Supernatant would be processed through a package water treatment plant. Solids from the treatment plant would be returned to be treated with the other solids. Treated water, with PCB levels below 1 ppb, would be discharged into the harbor or to a sanitary sewer.

The greatest potential for volatilization during dewatering would occur in the North Ditch. Dredged sediment slurry would require daily removal to allow for continued dredging, and excavation activities would cause air exposure and consequent volatilization. The lagoon would be excavated only once, minimizing the handling requirements. The elevated bins would experience minimal exposure to air, estimated at about 1 hour total exposure per bin-clearing operation. The highest reported concentration in Upper Harbor sediments is about 500 ppm PCBs. The maximum predicted PCB concentration in the air from solids removal operations is predicted to be less than 6.6 ug/m³. Typical concentrations range from 50 to 500 ppm PCBs. Average PCB concentrations in the air are expected to be less than 1.0 ug/m³ for sediments with 100 ppm PCBs (007). These values were extrapolated from data for sand, assuming 3.6-mph wind and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

Dewatered sediment would be fixed into a nonflowable form for transport, minimizing uncontrolled release of PCBs by spillage, leakage, or other means. Volatilization control during transport may require the use of covers. The fixed materials would be disposed of in a licensed chemical waste landfill, in compliance with State and Federal standards for PCB waste disposal.

The Upper Harbor would be cleaned of all sediments in excess of 50 ppm PCBs. If a 95 percent removal efficiency were achieved, it would remove an estimated 4,800 lb of PCBs in approximately 35,700 yd³ of sediment. This would remove about 1.5 percent of all the PCBs found in Slip No. 3 and Upper Harbor sediments.

The most significant uncontrolled dispersal of PCBs during cleanup would result from volatilization, and is estimated to be under 6.6 ug/m³, which is well below the OSHA standard of 1,000 ug/m³ (007).

Local land use would be temporarily impacted by the disposal, treatment, and transport preparation operations. Upon project completion, existing local land uses could resume. A temporary impact on Larsen Marine Services would occur during the actual dredging operations. Alternatives 2A and 2C, using the North Ditch or bins/cyclones/filters, would have a greater impact on Larsen Marine Services because dredging would be interrupted every other day for solids removal.

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterways) permit
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- IEPA water quality certification on all USCOE permits
- IEPA permit for construction of wastewater treatment facilities
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and IlCC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site
- Waukegan Port Authority dredging permit
- IDOT (Division of Waterways) permit for work in public waterways
- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

Alternative 3: Dredge-Dewater-Dispose. This alternative would remove by hydraulic dredge all sediment from the Upper Harbor that has PCB concentrations in excess of 50 ppm. Dredging activities would use a sediment dispersal control system (silt curtains or sheet piling) to minimize uncontrolled release of PCBs in the area. Because minimal volatilization is expected to occur at the dredge site (roughly

0.3 to 0.4 lb/day/acre from an exposed, agitated, and contaminated water area (030)), only low concentrations of PCBs would be released into the air (less than 2 ug/m³) (007).

Sediments would be dewatered in a lagoon to be constructed on OMC property. Dredged sediments would require mechanical dewatering using the RUC process (as described for Slip No. 3--Alternative 3) and evaporation to allow sufficient water removal for final disposal. The lagoon would be excavated by dragline after the top layer was sufficiently dry. The RUC process would be repeated until all the sediments were removed. Assuming the lagoon is 10 ft deep, the process is expected to require up to six repetitions.

All dredged materials would be fully contained in the lagoon. Supernatant would be processed through a package water treatment plant. Solids from the water treatment plant would be returned to be treated with the other solids. Treated water, with PCB levels below 1 ppb, would be discharged to the harbor or to a sanitary sewer.

These activities would cause significant air exposure and consequent volatilization. The highest reported concentration in Upper Harbor sediments is about 500 ppm PCB. The maximum predicted PCB concentration in air above these sediments would be less than 6.6 ug/m³, well below 1,000 ug/m³, the OSHA standard. The volatilization rate is predicted to be less than 5,375 ug/m²/hr. Typical concentrations are about 50 to 500 ppm PCBs. Predicted average PCB concentrations in the air would be less than 1.0 ug/m³ for sediments with 100 ppm PCBs. The average volatilization rate is expected to be about 725 ug/m²/hr or 1.4 lb/day of PCBs. These values were extrapolated from data for sand, assuming a wind speed of 3.6-mph and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

Dewatered sediments would be transported from the site by trucks that would use a watertight liner (plastic sheeting, etc.) to minimize spillage and leakage. The materials would also be covered to minimize volatilization in transit. The materials would be disposed of in a licensed chemical waste landfill, in compliance with State and Federal standards for PCB waste disposal.

The Upper Harbor would be cleaned of all sediments in excess of 50 ppm PCBs, amounting to an estimated 4,800 lb of PCBs in approximately 35,700 yd³ of sediments. This would remove about 1.5 percent of all the PCBs now found in Slip No. 3 and Upper Harbor sediments.

The most significant uncontrolled dispersal of PCBs during cleanup would result from volatilization, and is estimated to be under 6.6 ug/m³, which is well below the OSHA standard of 1,000 ug/m³ (007).

Local land use would be temporarily impacted by the disposal, treatment, and transport operations. Upon project completion, existing local land uses could resume.

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- IEPA permit for construction of wastewater treatment facilities
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and ILCC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site
- Waukegan Port Authority dredging permit
- IDOT (Division of Waterways) permit for work in public waterways
- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

Alternative 5: No Action. The No Action alternative will leave PCB concentrations between 50 and 500 ppm, representing an estimated 5,000 lb of PCBs, in the Upper Harbor. PCBs in these concentrations are regulated by 40 CFR 761 under TSCA.

The Upper Harbor PCBs will continue to contribute to the estimated 22 lb of PCBs released into Lake Michigan each year from Waukegan Harbor water (based on a steady state model) (035). The Waukegan area will continue to represent the most significant contributor to Lake Michigan PCB contamination, since it holds the largest known uncontained PCB mass in the lake basin. The potential for volatilization of PCBs will continue, contributing to the estimated 12 to 40 lb that are released from the harbor into the local airshed each year (007, 030, 035).

Channel dredging has been suspended because of PCB contamination, and shipping access to the harbor will eventually be eliminated. Harbor maintenance dredging of PCB-contaminated soils is expensive because of disposal and handling requirements. Huron Portland Cement and National Gypsum are now and will continue to be directly impacted, since they depend on the harbor to receive raw material shipments.

Slip No. 3 and Upper Harbor

Alternative 6: Contain-Dredge-Cap. A cofferdam would be constructed and a slurry cutoff wall would be placed around the containment area to contain the PCBs. The slurry wall would extend down into the natural glacial till to reduce future dispersion of PCBs into other sediment or groundwater. In Alternative 6A, approximately 33,500 yd^3 of contaminated sediment would be dredged from the Upper Harbor and disposed of within the contained area. If a 95 percent removal efficiency were achieved, 4,400 lb of PCBs would be moved within the containment area. This would contain about 310,000 lb of PCBs, or almost 100 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor. In Alternative 6B, approximately 13,100 yd^3 of contaminated sediments would be dredged from the east portion of Slip No. 3 and from the Upper Harbor and disposed of within the contained area. If a 95 percent removal efficiency were achieved, 3,600 lb of PCBs would be moved within the containment area. This would contain about 306,900 lb of PCBs, or about 99 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor. PCB concentrations in the air from the decanting water layer are expected to be less than 1 ug/m^3 (007, 030).

Dewatering effluent would be treated to 1 ppb in a package water treatment plant before discharge. After the area was filled, it would be capped with impermeable materials to seal in the contaminated soils, and to reduce surface water infiltration. Groundwater monitoring wells would be constructed to monitor potential PCB migration.

Containment of Slip No. 3 in this manner would require a USEPA waiver from the requirements of 40 CFR 761 of TSCA, since PCBs would remain in proximity to Lake Michigan and in an area with a high groundwater table (058).

Permit requirements are anticipated to include:

- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification in all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- IEPA permit for construction of wastewater treatment facilities
- City of Waukegan construction permits
- Local land use approval
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site
- Waukegan Port Authority dredging permit
- IDOT (Division of Waterways) permit for work in public waterways
- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

North Ditch Area

Alternative 1: Excavate-Dispose. Offsite drainage water would be routed by either pipeline or a lined open ditch to bypass the North Ditch and outfall directly into Lake Michigan. By bypassing the North Ditch, this water would avoid PCB contamination. The existing soil in the North Ditch would be dewatered via a well and pumping system to allow excavation. The water would be treated at an onsite package water treatment plant. Solids from the treatment plant would be disposed of with the other project solids. Treated water, with PCB levels below 1 ppb, would be discharged into the harbor or to a sanitary sewer.

Soils with PCB concentrations greater than 50 ppm would be excavated by backhoe and transported to a licensed chemical waste landfill for disposal in compliance with State and Federal standards for PCB waste disposal. Volatilization control during transport may require use of covers. The excavated areas would be backfilled with clean materials from an offsite borrow pit, causing topographic and other minor local impacts to the borrow area.

The highest reported concentration in the North Ditch soils is about 100,000 ppm (001). The predicted PCB concentration in air during excavation would be about 200 ug/m³. The volatilization rate is predicted to be about 163,000 ug/m²/hr. Typical concentrations range from 500 to 5,000 ppm PCBs. Predicted average PCB concentrations in the air would be less than 6.6 ug/m³. The average volatilization rate is expected to be less than 5,375 ug/m²/hr for soils with concentrations of 1,000 ppm PCBs. These values were extrapolated from data for sand, assuming 3.6-mph wind and an air temperature of 68°F (007). The volatilization rates from the sandy soils of the North Ditch area are expected to be closely approximated by these predictions.

If a 98 percent removal efficiency were achieved, it would remove an estimated 485,600 lb of PCBs in approximately 70,800 yd³ of soil. This would remove about 63 percent of all the PCBs now found in the North Ditch/Parking Lot area.

The bypass system would avoid further contamination of offsite drainage waters that currently run through the North Ditch. It is estimated that this would eliminate between 7 and 20 lb of PCBs discharged into Lake Michigan each year (032, 035).

The hydrologic system is not well enough understood at present to determine the extent of past or future PCB contamination by groundwater movement. The removal of all soils with PCB concentrations greater than 50 ppm would minimize the potential for future groundwater contamination.

Permit requirements are anticipated to include:

- Well water removal permit (State)
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- IEPA permit for construction of wastewater treatment facilities
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and IlCC)

- USEPA toxic substances disposal approval

- IEPA approval if material is disposed in a currently non-PCB-approved site

- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

Alternative 3: Excavate-Fix-Dispose. Offsite drainage water would be routed by either pipeline or lined open ditch to bypass the North Ditch and outfall directly into Lake Michigan. By bypassing the North Ditch, this water would avoid PCB contamination. The existing soil in the North Ditch would be dewatered via a well and pumping system to allow excavation. The water would be treated at an onsite package water treatment plant. Solids from the treatment plant would be disposed of with the other project solids. Treated water with PCB levels below 1 ppb, would be discharged to the harbor or to a sanitary sewer.

Soils with PCB concentrations greater than 50 ppm would be excavated by backhoe. If a 96 percent removal efficiency were achieved, it would amount to an estimated 485,600 lb of PCBs in approximately 70,800 yd^3 of soil. This would remove about 63 percent of all the PCBs now found in the North Ditch/Parking Lot area.

Excavated soil would be fixed in nonflowable form. The fixed materials would then be disposed of in a licensed chemical waste landfill, in compliance with State and Federal standards for PCB waste disposal. Control of volatilization during transport may require the use of covers. Excavated areas would be backfilled with clean materials from an offsite borrow pit, causing topographic and other minor local impacts to the borrow area.

The bypass system would avoid further contamination of offsite drainage water that currently runs through the North Ditch. It is estimated that this would eliminate between 7 and 20 lb of PCBs discharged into Lake Michigan each year (032, 035).

The hydrologic system is not well enough understood at present to determine the extent of past or future PCB contamination by groundwater movement. The removal of all soils with PCB concentrations greater than 50 ppm would minimize the potential for future groundwater contamination.

The highest reported concentration in the North Ditch soils is about 100,000 ppm (001). The predicted PCB concentration in air during excavation would be about 200 ug/m^3. The volatilization rate is predicted to be about 163,000 $ug/m^2/hr$. Typical concentrations range from 500 to 5,000 ppm PCBs. Predicted average PCB concentrations in the air would be less than 6.6 ug/m³. The average volatilization rate is expected to be less than 5,375 ug/m²/hr for soils with concentrations of 1,000 ppm PCBs. These values were extrapolated from data for sand, assuming a 3.6-mph wind and an air temperature of 68°F (007). The volatilization rates from the sandy soils of the North Ditch area are expected to be closely approximated by these predictions.

Permit requirements are anticipated to include:

- Well water removal permit (State)
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- IEPA permit for construction of wastewater treatment facilities
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and ILCC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site
- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

Alternative 4: Excavate-Contain-Cap. Alternative 4 would use a nonstructural slurry wall around the perimeter of the Crescent Ditch and Oval Lagoon area. The slurry wall would extend down into the existing glacial till beneath the local sand (about 35 ft deep). This would reduce future dispersion of PCBs into other soil or groundwater. The existing soil in the North Ditch would be dewatered via a well and pumping system to allow excavation. The water would be treated at an onsite package water treatment plant. Solids from the treatment plant would be disposed of with the other project solids. Treated water, with PCB levels below 1 ppb, would be discharged into the harbor or to a sanitary sewer.

In Alternative 4A, approximately 25,000 yd^3 of soils with PCB concentrations greater than 50 ppm would be excavated from the east-west portion of the North Ditch. If a 98 percent removal efficiency were achieved, 4,200 lb of PCBs would be excavated. This would contain 495,400 lb of PCBs, or almost 100 percent of all the PCBs now found in the North Ditch/Parking Lot area. In Alternative 4B, approximately 5,600 yd^3 of soils with PCB concentrations greater than 50 ppm would be excavated from the east-west portion of the North Ditch. If a 98 percent removal efficiency were achieved, 800 lb of PCBs would be excavated. This would contain 492,000 lbs of PCBs, or 99 percent of all the PCBs now found in the North Ditch/ Parking Lot area. The Crescent Ditch would be excavated to a depth of 3 ft. Excavated soils would be placed in the Oval Lagoon area. The area would be capped with impermeable materials to seal in the contaminated soils and reduce surface water infiltration. The Crescent Ditch area would be paved and the Oval Lagoon area would be seeded.

The highest reported concentration in the east-west portion of the North Ditch is greater than 5,000 ppm PCB. The maximum predicted PCB concentration in air during excavation would be less than 43 ug/m^3. The volatilization rate is predicted to be less than 35,000 $ug/m^2/hr$. Typical concentrations range from 500 to 5,000 ppm PCBs. Predicted average PCB concentrations in the air would be about 6.6 ug/m^3 for soils with concentrations of 1,000 ppm PCBs. The average volatilization rate is expected to be about 5,375 $ug/m^2/hr$. These values were extrapolated from data for sand, assuming a wind speed of 3.6-mph and an air temperature of 68°F (007). The volatilization rates from the sandy soils of the North Ditch are expected to be closely approximated by these predictions.

Containment would protect adjacent soils and would reduce groundwater contamination and volatilization. Capping would raise the elevation of the Oval Lagoon area. Groundwater monitoring wells would be constructed to monitor the effectiveness of the slurry wall.

Containment of the North Ditch area in this manner would require a USEPA waiver from the requirements of 40 CFR 761 under TSCA, since PCBs would remain in proximity to Lake Michigan and in an area with a high groundwater table (058).

The bypass system would avoid further contamination of offsite drainage waters that currently run through the North Ditch. It is estimated that this would eliminate between 7 and 20 lb of PCBs discharged into Lake Michigan each year (032, 035).

Permit requirements are anticipated to include:

- Well water removal permit (State)

- USCOE Section 404 (disposal in waterways) permits
- City of Waukegan construction permits
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- Local land use approval
- IEPA permit for construction of wastewater treatment facilities
- IEPA (Division of Land and Noise) special waste hauler's permit
- USEPA toxic substances disposal approval
- Certification of Authority to haul PCB commodities (ICC and ILCC)
- IEPA approval if material is disposed in a currently non-PCB-approved site
- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

Alternative 5: No Action. The No Action alternative will leave PCB concentrations in excess of 10,000 ppm in areas of the Crescent Ditch and Oval Lagoon and PCB concentrations between 50 and 10,000 ppm in the soil and sediments of the North Ditch area (001). This represents an estimated 495,500 lb of PCBs in the soil at the North Ditch. PCBs in these concentrations are regulated by 40 CFR 761 under TCSA.

Offsite drainage entering the North Ditch will continue to become contaminated, discharging PCBs into Lake Michigan. Groundwater resources will also continue to be contaminated, with the extent of groundwater contamination unknown. It is estimated that 7 to 20 lb of PCBs are discharged annually into Lake Michigan from the North Ditch (032, 035).

Existing air contamination from North Ditch waters is estimated at 15 lb/yr (004). Air contamination from local soils is not known, although the potential for exposure from accidental disturbance remains high.

Parking Lot Area

Alternative 1: Excavate-Dispose. Alternative 1 would dewater existing contaminated soils by a well and pumping system. Water drawn from the site would be treated at the package water treatment plant. Solids from the treatment plant would be disposed of with the other project solids. Treated water, with PCB levels below 1 ppb, would be discharged into the harbor or to a sanitary sewer.

Dewatered soil would be excavated by backhoe or front end loader and transported to a licensed chemical waste landfill for disposal in compliance with State and Federal standards for PCB waste disposal. Volatilization control during transport may require use of covers.

The highest reported concentration in Parking Lot area soils is less than 10,000 ppm (001). The predicted PCB concentration in air during excavation would be less than 43 ug/m^3, well below 1,000 ug/m^3, the OSHA standard. The volatilization rate is predicted to be less than 35,000 ug/m^2/hr. Typical concentrations range from 50 to 5,000 ppm PCBs. Predicted average PCB concentrations in the air would be about 6.6 ug/m^3 for soils with concentrations of 1,000 ppm PCBs. The average volatilization rate is expected to be about 5,375 ug/m^2/hr. These values were extrapolated from data for sand assuming a 3.6-mph wind and an air temperature of 68°F (007). The volatilization rates from the sandy soils of the Parking Lot area are expected to be closely approximated by these predictions.

Excavated areas would be backfilled with clean borrow materials brought in from offsite. The borrow site would probably experience topographic and other minor local impacts.

Soil with PCB levels greater than 50 ppm would be removed. If a 98 percent removal efficiency were achieved, it would remove an estimated 272,100 lb of PCBs in approximately 105,000 yd^3 of soils. This would remove about 35 percent of all the PCBs now found in the North Ditch/Parking Lot area.

Permit requirements are anticipated to include:

- Well water removal permit (State)
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- IEPA permit for construction of wastewater treatment facilities
- IEPA (Division of Land and Noise) special waste hauler's permit

- City of Waukegan construction permits

- Local land use approval

- Certification of Authority to haul PCB commodities (ICC and ILCC)

- USEPA toxic substances disposal approval

- IEPA approval if material is disposed in a currently non-PCB-approved site

- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

<u>Alternative 3: Excavate-Fix-Dispose</u>. Alternative 3 would dewater existing contaminated soil by a well and pumping system. Water drawn from the site would be treated at the package water treatment plant. Solids from the treatment plant would be disposed of with the other project solids. Treated water, with PCB levels below 1 ppb, would be discharged into the harbor or to a sanitary sewer.

Dewatered soils would be excavated by backhoe or front end loader. Excavated areas would be backfilled with clean borrow materials brought in from offsite. The borrow site would probably experience topographic and other minor local impacts.

The highest reported concentration in Parking Lot area soils is less than 10,000 ppm (001). The predicted PCB concentration in air during excavation would be less than 43 ug/m^3, well below 1,000 ug/m^3, the OSHA standard. The volatilization rate is predicted to be less than 35,000 $ug/m^3/hr$. Typical concentrations range from 50 to 5,000 ppm PCBs. Predicted average PCB concentrations in the air would be about 6.6 ug/m^3 for soils with concentrations of 1,000 ppm PCBs. The average volatilization rate is expected to be about 5,375 $ug/m^3/hr$. These values were extrapolated from data for sand, assuming a 3.6-mph wind and an air temperature of 68°F (007). The volatilization rates from the sandy soils of the Parking Lot area are expected to be closely approximated by these predictions.

Excavated soil would be fixed into a nonflowable form for transport to a licensed chemical waste landfill. This would minimize uncontrolled release of PCBs by spillage, leakage, or other means. Control of volatilization during transport may require the use of covers. Fixed materials would be disposed of in a licensed chemical waste landfill, in compliance with State and Federal standards for PCB waste disposal. Fixation may not be necessary if the contaminated soil (mostly sand) can be excavated in a nonflowable state.

Soil with PCB levels greater than 50 ppm would be removed. If a 98 percent removal efficiency were achieved, it would amount to an estimated 272,100 lb of PCBs in approximately 105,000 yd^3 of soils. This would remove about 35 percent of all the PCBs now found in the North Ditch/Parking Lot area.

Permit requirements are anticipated to include:

- Well water removal permit (State)
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- IEPA permit for construction of wastewater treatment facilities
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and ILCC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site
- North Shore Sanitary District approval if water discharge goes to the sanitary sewer

Alternative 4: Contain-Cap. Alternative 4 would use a slurry wall around the perimeter of the soil with greater than 50 ppm PCBs, containing an estimated 277,700 lb of PCBs. The slurry wall would extend down into the existing glacial till beneath the local sand (about 35 ft deep). This would reduce future dispersion of PCBs into other soil or groundwater. The site would be capped with impermeable materials to seal in the contaminated soils and to reduce surface water infiltration. The area would be resurfaced for future parking.

Containment would protect adjacent soils and would reduce groundwater contamination and volatilization. Capping would raise the elevation of the Parking Lot area. Groundwater monitoring wells would be constructed to monitor the effectiveness of the slurry wall.

Containment of the Parking Lot in this manner would require a USEPA waiver from the requirements of 40 CFR 761 under TSCA, since PCBs would remain in proximity to Lake Michigan and in an area with a high groundwater table (058).

Permit requirements are anticipated to include:

- City of Waukegan construction permit
- Local land use approval
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site

Alternative 5: No Action. The No Action alternative will leave PCB concentrations from 50 to over 5,000 ppm in the Parking Lot area. This represents an estimated 277,700 lb of PCBs. PCBs in these concentrations are regulated by 40 CFR 761 under TSCA.

The groundwater is within 3 feet of the surface of the Parking Lot, resulting in contamination of this water. It is estimated that the slowly moving water will begin releasing some 8 lb per day of PCBs into Lake Michigan in approximately 60 years (048). This will result in further contamination of local water and soil, which will continue for decades thereafter.

Although volatilization of contaminated soil in the Parking Lot does not appear to be occurring now because it is paved, the potential exists if the soil is disturbed. Grading, trenching, drilling, digging, or other activities necessary for utility installation, drainage, or other construction projects could cause volatilization of PCBs.

RECOMMENDED ALTERNATIVES FOR DETAILED EVALUATION

Based on the initial screening of alternatives, the recommended Remedial Action Alternatives for detailed evaluation are presented in the flow diagrams of Figures 4-1 through 4-5. In accordance with CERCLA, the No Action alternative has been eliminated from further consideration for all areas because: (1) there has been a release of a hazardous substance from a facility (PL 96-510 Section 104(a)(1)); (2) lack of remedial action at Slip No. 3 and the Upper Harbor would impact the local industrial, commercial, and recreational users of the harbor; (3) PCB accumulation in fish would impact the local fishing industries; (4) a potential exists for spread of PCB contamination either by natural or manmade events from uncontrolled PCBs regulated by 40 CFR 761.

The results of the initial screening process are summarized as follows:

Slip No. 3

After refining the initial screening alternatives for engineering feasibility, the following alternatives were evaluated for cost-effectiveness and environmental impacts:

Alternative 2A:	Dredge-Dewater in North Ditch-Fix-Dispose
Alternative 2B:	Dredge-Dewater in Lagoon-Fix-Dispose
Alternative 2C:	Dredge-Dewater in Bins/Cyclones/Filters-Fix-Dispose
Alternative 2D:	Dredge-Dewater in Barges-Fix-Dispose
Alternative 3:	Dredge-Dewater in Lagoon-Dispose

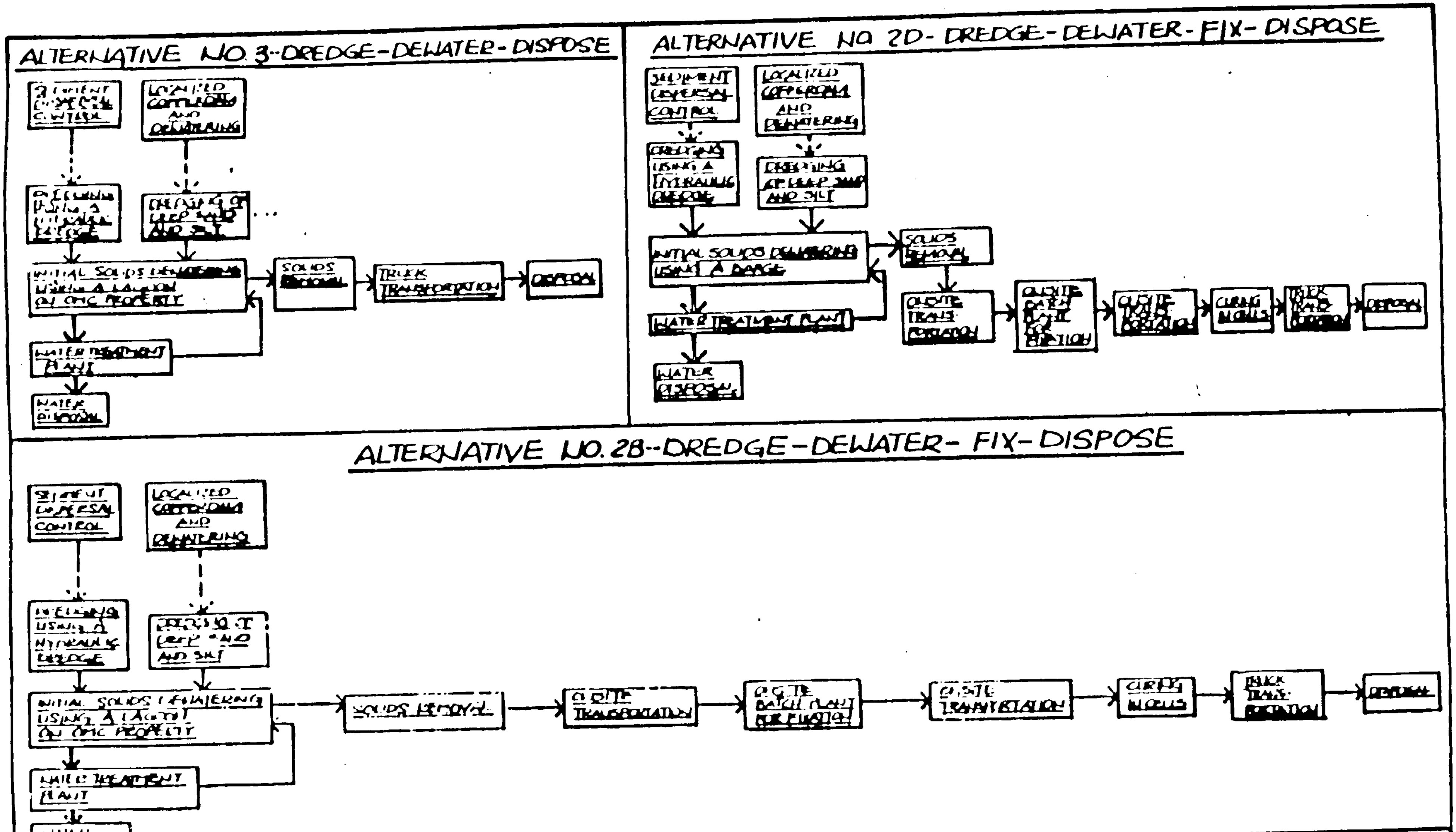
Based on the initial screening, the cost-effective alternatives appear to be 2B, 2D, and 3. Dewatering the dredged sediments in a lagoon without fixation resulted in the least cost. From an environmental standpoint, dewatering in barges and fixing the material for prompt disposal resulted in the least short-term environmental impact. These three alternatives were retained for detailed evaluation.

Upper Harbor

After refining the initial screening alternatives for engineering feasibility, the following alternatives were evaluated for cost-effectiveness and environmental impacts:

Alternative 2A:	Dredge-Dewater in North Ditch-Fix-Dispose
Alternative 2B:	Dredge-Dewater in Lagoon-Fix-Dispose
Alternative 2C:	Dredge-Dewater in Bins/Cyclones/Filters-Fix-Dispose
Alternative 3:	Dredge-Dewater in Lagoon-Dispose

Based on the initial screening, the cost-effective alternatives appear to be 2B and 3. Dewatering dredged sediments in a lagoon without fixation resulted in the least cost. From an environmental standpoint, dewatering in a lagoon and fixing the material for prompt disposal resulted in the least short-term environmental impact. These two alternatives were retained for detailed evaluation.



LEGEND

EXCAVATED MATERIALS OR SOLIDS

WATER ONLY

REQUIRED PRECEDENT ACTIVITY

FIGURE 4-1
DETAILED EVALUATION ALTERNATIVES

Slip No. 3 and Upper Harbor

After refining the initial screening alternatives for engineering feasibility, the following alternatives were evaluated for cost-effectiveness and environmental impacts:

Alternative 6A: Contain-Dredge-Cap

Alternative 6B: Contain-Dredge part of Upper Harbor-Cap

Based on the initial screening, the cost-effective alternatives for Slip No. 3 and Upper Harbor appear to be Alternatives 6A and 6B.

North Ditch Area

After refining the initial screening alternatives for engineering feasibility, the following alternatives were evaluated for cost-effectiveness and environmental impacts:

Alternative 1: Excavate-Dispose

Alternative 3: Excavate-Fix-Dispose

Alternative 4A: Excavate-Contain-Cap

Alternative 4B: Excavate-Contain part of the North Ditch-Cap

Based on the initial screening, the cost-effective alternatives for the North Ditch area appear to be Alternatives 4A and 4B. Alternatives 1 and 3 were also included in the alternatives retained for detailed evaluation because offsite disposal of PCB-contaminated soils resulted in lower long-term environmental impacts, although the short-term environmental impacts would be higher than for Alternatives 4A and 4B.

Parking Lot Area

After refining the initial screening alternatives for engineering feasibility, the following alternatives were evaluated for cost-effectiveness and environmental impacts:

Alternative 1: Excavate-Dispose

Alternative 3: Excavate-Fix-Dispose

Alternative 4: Contain-Cap

Based on initial screening, the cost-effective alternative for the Parking Lot area appears to be Alternative 4. Alternatives 1 and 3 were also included in the alternatives retained for detailed evaluation because offsite disposal of PCB-contaminated soils resulted in lower long-term environmental impacts, although the short-term environmental impacts would be higher than for Alternative 4.

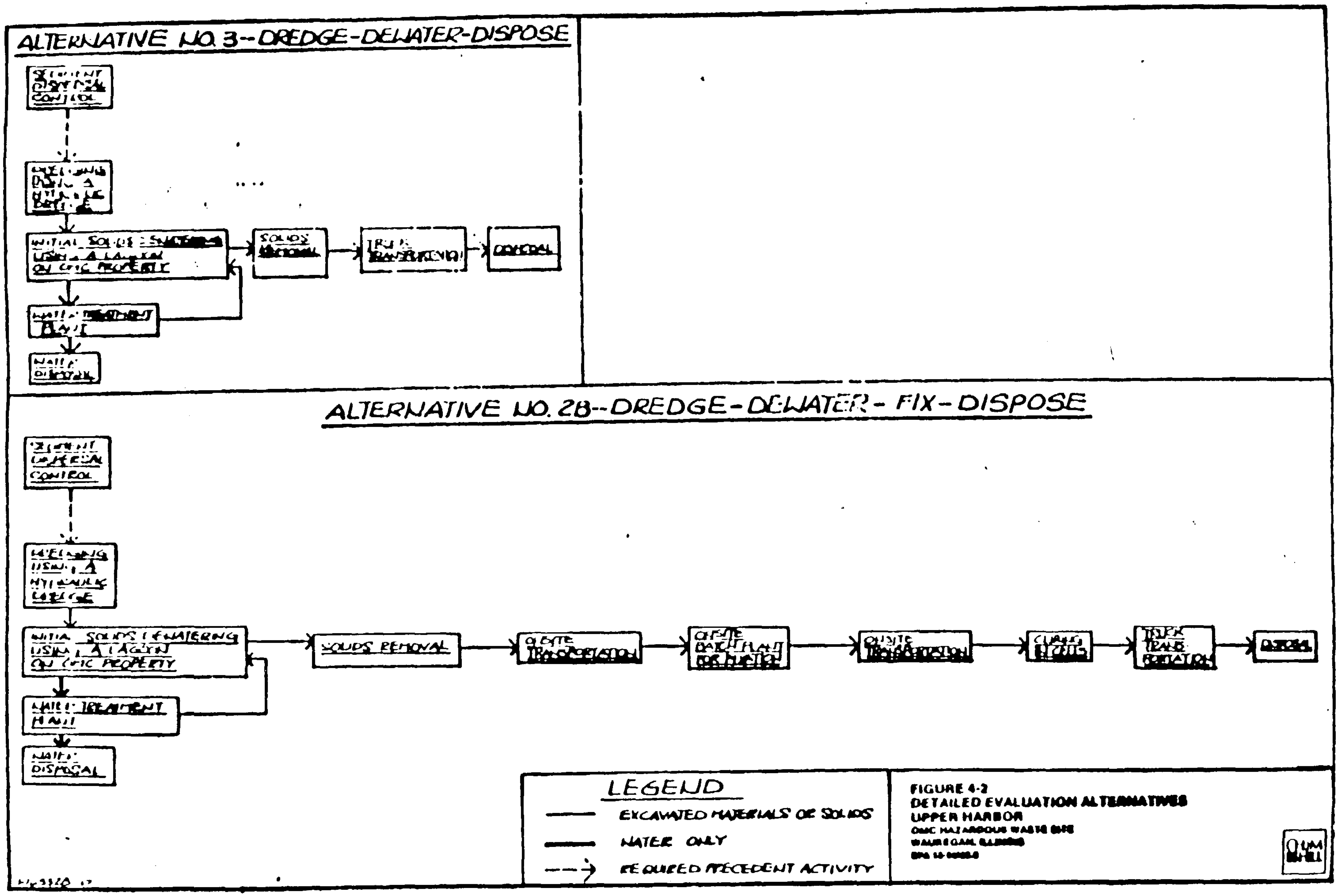


FIGURE 4-2
DETAILED EVALUATION ALTERNATIVES
UPPER HARBOR
OMC HAZARDOUS WASTE SITE

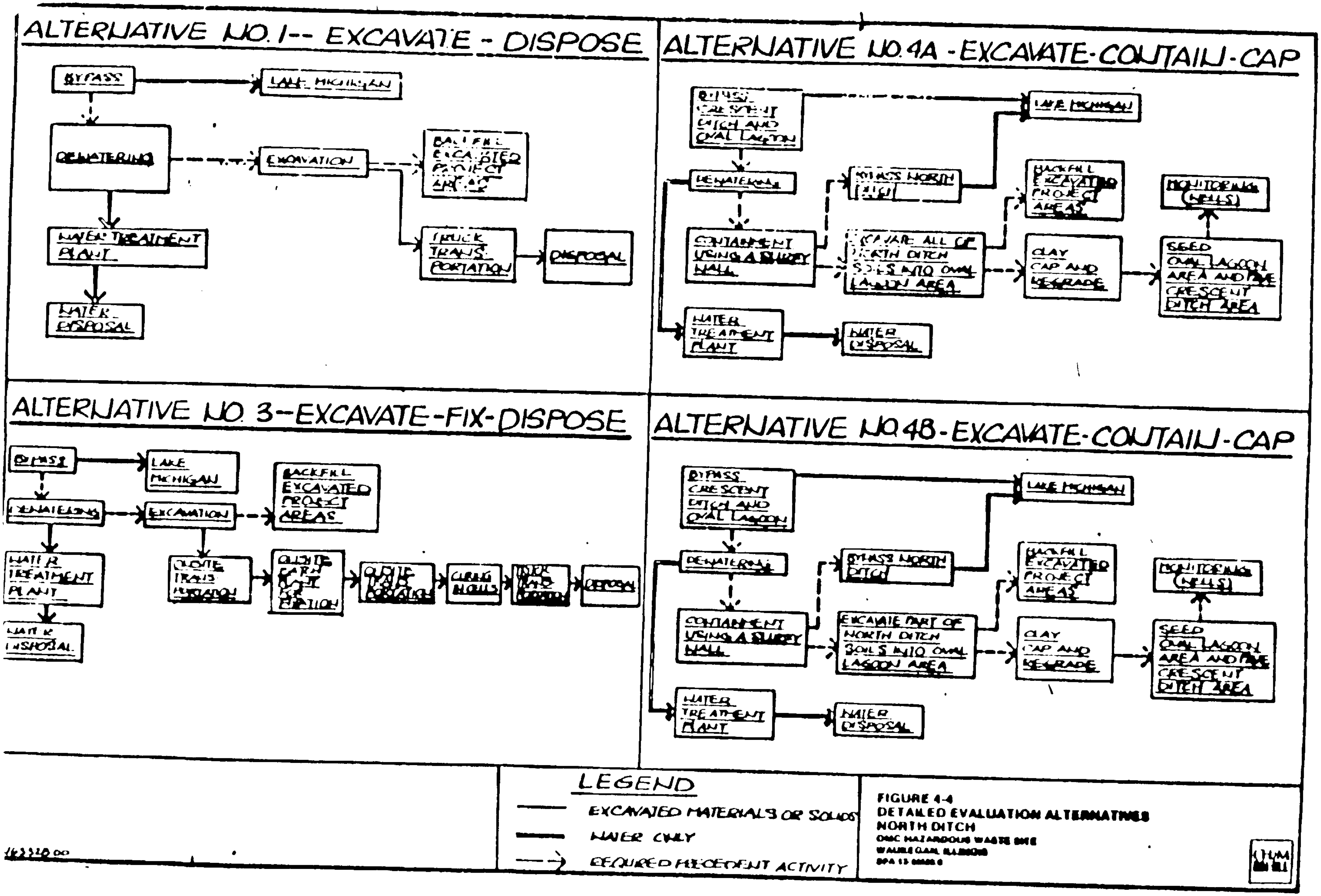
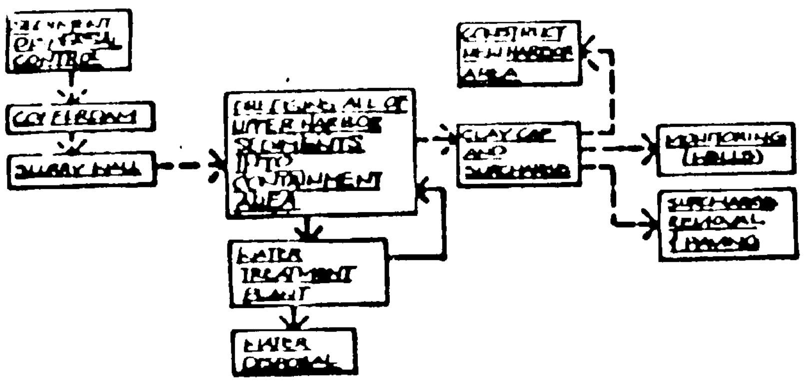
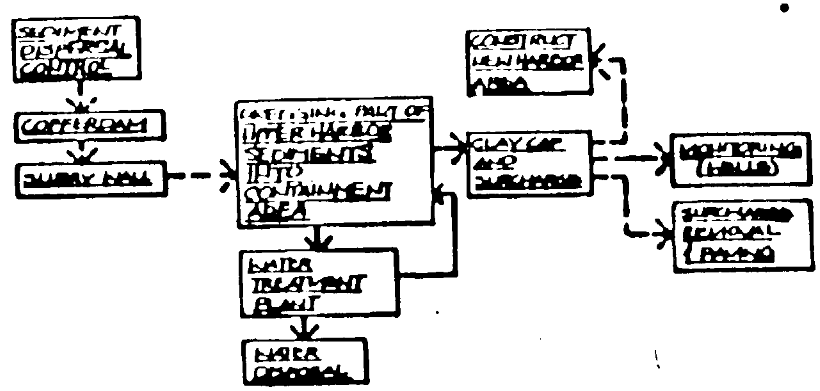


FIGURE 4-4
DETAILED EVALUATION ALTERNATIVES
NORTH DITCH
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

ALTERNATIVE NO. 6A-CONTAIN-DREDGE-CAP



ALTERNATIVE NO. 6B-CONTAIN-DREDGE-CAP



LEGEND

- EXCAVATED MATERIALS OR SOLIDS
- WATER ONLY
- REQUIRED PRECEDENT ACTIVITY

FIGURE 4-3
DETAILED EVALUATION ALTERNATIVES
SLIP NO. 3 AND UPPER HARBOR
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

CH2M HILL

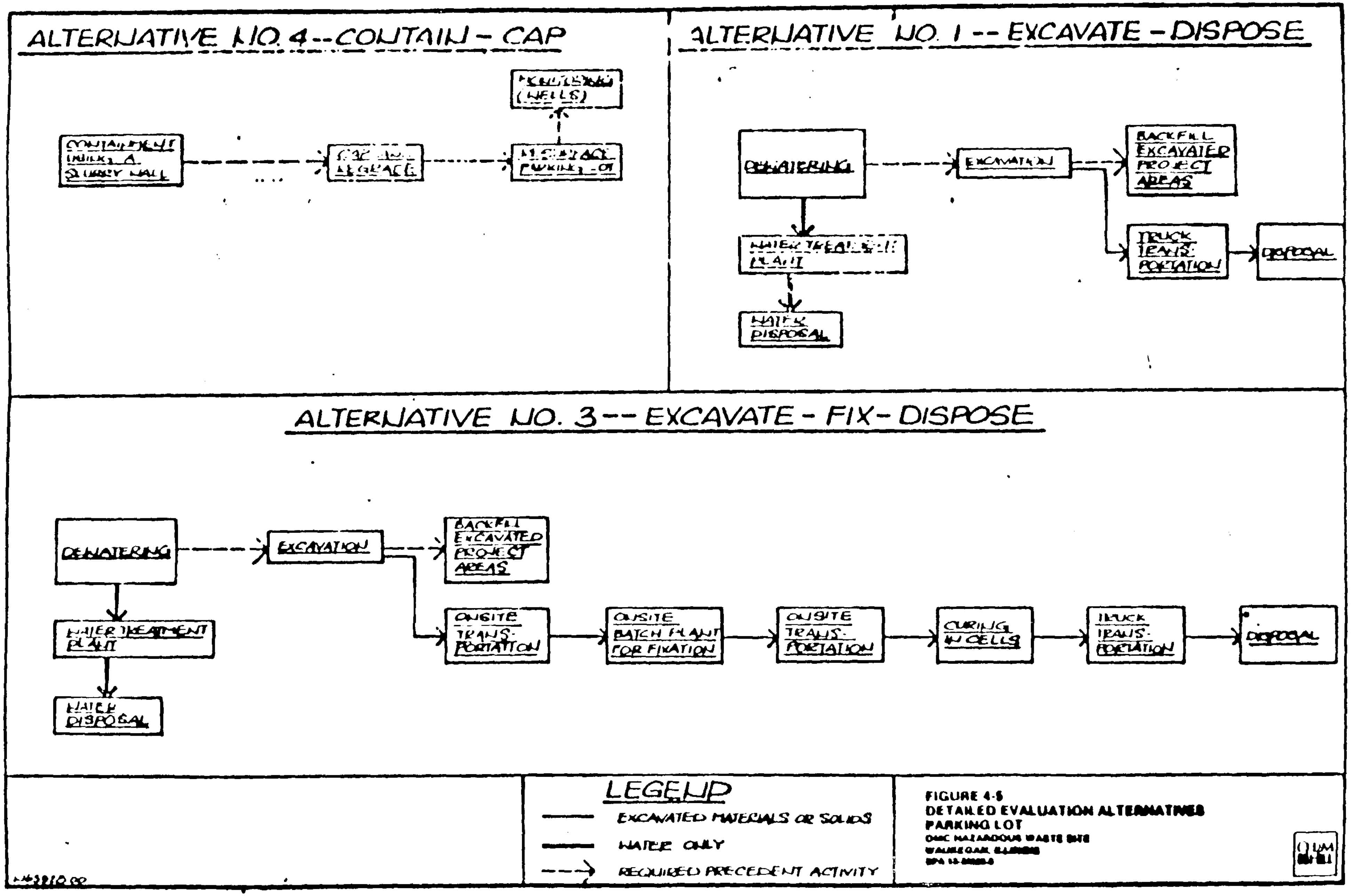


FIGURE 4-5
DETAILED EVALUATION ALTERNATIVES
PARKING LOT
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

Section 5
DETAILED EVALUATION--ENGINEERING AND COST ASPECTS

The purpose of the evaluation presented in this section was to develop detailed information to evaluate the alternatives retained from initial screening. Detailed evaluation was accomplished by more fully developing the engineering aspects of each alternative, identifying in more detail the potential environmental impacts of each alternative, and developing Order-of-Magnitude cost estimates (as defined in Section 1) for each alternative. This section discusses the detailed engineering evaluation and costs of the alternatives retained in Section 4. The environmental aspects of these alternatives are discussed in Section 6.

SLIP NO. 3

Alternative 2B: Dredge-Dewater in Lagoon-Fix-Dispose

A sediment dispersal control device, consisting of a double silt curtain or sheet piling, would be installed across the mouth of Slip No. 3 (Figure 5-1). Sediments with greater than 50 ppm PCBs would be removed with a hydraulic dredge and the sediment slurry pumped through a pipeline to the initial solids dewatering lagoon. Because the hydraulic dredge cannot penetrate the area of deep contaminated sand and silt near the OMC outfall, a mechanical dredge would be used to remove this material.

This deep dredging would be performed inside a single sheet pile cofferdam. The solids would be loaded onto trucks and transported to the initial solids dewatering lagoon. The water level inside the cofferdam would be kept lower than outside to cause water flow toward the contained area. The removed water would be routed to a water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the harbor or to a sanitary sewer.

Solids would be dewatered in a clay-lined dewatering lagoon constructed on OMC property. Volatilization would be controlled by covering the filled lagoon surface with organic sludge. The supernatant would be continuously decanted and routed to a 1,500-gpm water treatment plant to remove suspended solids and dissolved PCBs down to 1 ppb before being discharged. After dredging activities are completed, rainwater and leachate water would be treated by the 1,500-gpm water treatment plant for the duration of the dewatering process.

Solids would be removed from the lagoon by dragline about 2 months after dredging activities are completed, loaded into trucks, and transported to the batch plant.

The solids would be fixed at the batch plant by adding portland cement, Locksorb, or another fixing agent to hydrate the excess water. The mix would then be transported to curing cells. The fixed solids would cure until they were nonflowable. This is expected to take about 1 day. The fixed solids would be removed from the curing cells by front end loaders for transportation by truck to an approved disposal site.

Lagoon. A 24,000-yd^3 lagoon would be required to dewater sediments from Slip No. 3. The assumed shape and location of the proposed lagoon are shown on Figure 5-1. The capacity of the lagoon is based on 2 ft of freeboard and 8 ft of storage. The lagoon would have a clay liner system consisting of the following:

- A 6-inch-thick, compacted soil-cement layer would be constructed to prevent removal of the clay liner during solids removal.

- A 1-ft-thick, compacted clay liner with a permeability less than 10^{-8} centimeters per second (cm/sec) would be constructed to prevent percolation of PCB-contaminated water. It would take about 4 years for the PCB-contaminated water to penetrate the 1-ft-thick clay liner.

- A 1-ft-thick sand or gravel layer with pipe underdrains would be constructed to collect any PCB-contaminated water that may penetrate the clay liner.

- A 1-ft-thick, compacted clay liner with a permeability less than 10^{-8} cm/sec would be constructed for additional protection against percolation of PCB-contaminated water.

Curing Cells. Three 1,400-yd^3 curing cells would be required to cure the fixed solids from the batch plant. The assumed shape and location of the proposed curing cells are shown on Figure 5-1. The capacity of the curing cells is based on 1 ft of freeboard and 4 ft of storage. The earth-lined cells would have the same clay liner system as described for the lagoons in Slip No. 3--Alternative 2B. In addition, the curing cells would have 2-ft-thick, 5-ft-high concrete walls to divide the earth-lined area into three compartments.

Temporary Storage Requirements. Dredged solids would require temporary storage in a lagoon for dewatering. For Slip No. 3--Alternative 2B, dewatering is expected to take 2 months after dredging activities are completed. When the solids are removed from temporary storage, they would be fixed and would require an additional day of temporary storage for curing. After curing, they would be disposed of in a licensed chemical waste landfill.

<u>Water Treatment</u>. Slurry water from dredging activities would need to be treated before being discharged.

Laboratory tests conducted by Mason & Hanger (004) demonstrated that the slurry water from dredging activities could be treated by available conventional and advanced water treatment processes to meet the discharge requirement of 1 ppb PCBs.

Water treatment would consist of:

- Coagulation/sedimentation to coagulate and settle fine sediments that were not removed in the initial solids dewatering lagoon (using alum and/or cationic polymer)
- Sand filtration to remove suspended solids
- Carbon filtration to remove soluble PCBs
- A clearwell to monitor PCB levels before the water is discharged

The water treatment system would be a "package plant," of factory-constructed modules, that could be easily installed and removed. The package plant would have the capacity to treat 1,500 gpm. The lagoon would act as an equalization basin to hold up to 1,000 gpm for a 2-hour detention time. The water treatment plant would operate continuously. If the water level in the lagoon drops to the sediment/water interface, the treated water would be recycled. This water treatment plant would be used during the dredging of Slip No. 3 and the localized area. In addition, rainwater and leachate water would need treatment on an intermittent basis for about 3 months during dewatering.

PCB concentrations in the water in Slip No. 3, confined by sediment dispersal control consisting of either a double silt curtain or sheet piling, are not expected to exceed 1 ppb (035). Therefore, the in-place waters may not require treatment. If higher-than-allowable concentrations of PCBs in solution are found after dredging, however, treatment of the water confined by the sediment dispersal control device may consist of adding one or both of the following treatment materials directly to Slip No. 3:

- Cationic polymer or alum to coagulate and settle fine suspended sediments
- Activated carbon to remove soluble PCBs

A dredge would then remove the settled activated carbon and solids confined by the sediment dispersal control device.

Major treatment equipment and utilities that would be required for the 1,500-gpm water treatment system for Slip No. 3--Alternative 2B include:

- Intake pumps, valves, and process piping
- Polymer (or alum) feed systems
- Concrete sedimentation basin
- Pressure filter pumps
- Pressure sand filters
- Carbon adsorption filters
- Turbidity meters
- Modular steel tank clearwell
- Clearwell pumps
- Liquid level controls, pump controls, and control panel
- Leachate sump pumps
- Electrical service to all equipment
- Electrical lighting system
- Onsite water quality laboratory

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. In Slip No. 3--Alternative 2B, the proposed action would remove the PCBs from the project site and dispose of them in a licensed chemical waste landfill. Therefore, there would be no onsite long-term operation, maintenance, or monitoring requirements after completing the proposed remedy.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. In Slip No. 3--Alternative 2B, about 14,200 yd^3 of fixed PCB-contaminated solids, about 5,800 yd^3 of contaminated liner material, and 2,300 yd^3 of contaminated volatilization control material would require disposal. In addition, about 39,000 yd^3 of uncontaminated lagoon embankment material would require disposal. At this writing, CECOS in Williamsburg, Ohio, is the closest chemical waste landfill licensed to receive PCBs. Under CECOS management, available space was confirmed for disposal of these wastes. Transportation would be provided by CECOS.

BFI, located 13 miles from the OMC site, is a licensed hazardous waste disposal facility that could be licensed to receive PCBs. Such licensing could be accomplished by means of a one-time TSCA permit for this project. BFI has confirmed that space is available for disposal of these wastes. BFI would also provide transportation to its landfill. Construction documents prepared during final design should allow competitive bidding between the operators of suitable facilities.

Major Equipment. Major construction equipment and utilities required for Slip No. 3--Alternative 2B include:

- Pile driver
- Hydraulic and clamshell dredge
- Bulldozer
- Compactor
- Scarifier/mixer
- Dump trucks
- Front end loader
- Backhoe
- Dragline
- Batch plant
- Water treatment plant (see Water Treatment earlier in this section)
- Electrical service for batch plant
- Electrical lighting
- Water service for contractor's temporary facilities

Special Engineering Considerations. For Slip No. 3--Alternative 2B the following special engineering considerations are presented.

Engineering considerations concerning the dredging of Slip No. 3 include:

- Type of dredge head and rate and pattern of dredging to minimize roiling of sediments

- Type of sediment dispersal control to minimize possibility of contaminating the emergency drinking water supply intake located at the mouth of the harbor

- Stability of sheet piles surrounding Slip No. 3

- Type of cofferdam for dredging of deep contaminated sand and silt near former OMC outfall, and means to prevent failure of existing sheet piling during cofferdam installation and removal

Engineering considerations concerning the initial solids dewatering lagoon include:

- Construction techniques necessary to obtain satisfactory permeabilities in the clay liner

- Durability of the soil-cement

- Determining how much of the lagoon liner material must be disposed of in a licensed PCB disposal facility

Engineering considerations concerning the sediment dewatering process include:

- Determining the moisture content of sediments to be removed after dewatering

- Controlling volatilization

Engineering considerations concerning fixation include:

- Moisture content of solids to be fixed

- Amount of fixing agent required

- Volume of fixing agent

- Volume of solids to be removed

- Possible interferences of contaminants with the fixing agent

- Time required for curing

- Cost-effectiveness of fixing with portland cement, Locksorb, and/or other fixing agent

Engineering considerations concerning the water treatment process include:

- Determining the cost-effectiveness of replacing activated carbon with Klensorb for soluble PCB removal if the activated carbon should become blinded by the oily nature of PCBs

- Water quality requirements for discharging to the harbor or to a sanitary sewer

Engineering considerations concerning disposal of the PCB-contaminated sediments include:

- Ensuring that the sediments have a nonflowable consistency

- Ensuring that moisture or solids do not escape during transport and disposal of the fixed sediments

- Controlling volatilization

Reliability. Slip No. 3--Alternative 2B would remove PCB-contaminated sediment with concentrations greater than 50 ppm from Slip No. 3. The alternative includes dredging, dewatering, water treatment, sediment solidification, and disposal in a licensed chemical waste landfill. This alternative would be effective in abating further PCB contamination of the Waukegan area and Lake Michigan. Slip No. 3--Alternative 2B is considered reliable.

Costs. The Order-of-Magnitude cost estimate for Slip No. 3--Alternative 2B is presented in Table 5-1. A present-worth analysis was used.

The cost estimates shown were prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The costs were based on second quarter 1983 dollars. The final costs of the project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project costs may vary from the estimates presented herein.

A description of the major elements included in the Table 5-1 line items for Slip No. 3--Alternative 2B follows:

- Mobilization includes the contractor costs to start up the job, transfer work crews and equipment to the site, and provide temporary facilities, as well as insurance and bonds. Mobilization costs were estimated at 10 percent of the total costs for all the line items except health and safety requirements and engineering, legal, and administration.

Table 5-1

DETAILED COST ESTIMATE
SLIP NO. 3
ALTERNATIVE 2B
DREDGE-DEWATER IN LAGOON-FIX-DISPOSE
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M2B.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 600,000	0	$ 600,000
Health and safety requirements	330,000	0	330,000
General site preparation	290,000	0	290,000
Sediment dispersal control	60,000	0	60,000
Dredging	60,000	0	60,000
Localized cofferdam and dewatering	390,000	$ 60,000	450,000
Dredging of deep sand and silt	20,000	0	20,000
Initial solids dewatering—lagoon	1,570,000	10,000	1,580,000
Water treatment plant and water disposal	1,260,000	60,000	1,320,000
Solids removal	60,000	0	60,000
Fixation	1,580,000	0	1,580,000
Transportation and disposal	710,000	0	710,000
Engineering, legal, and administration	1,180,000	20,000	1,200,000
Subtotal	8,110,000	150,000	8,260,000
Contingency	2,430,000	50,000	2,480,000
Total	$10,540,000	$200,000	$10,740,000

- Health and safety requirements includes the contractor costs for workers' personal protection and surveillance equipment and materials. They also would include special equipment and facilities for decontamination. Health and safety costs were estimated at 5 percent of the total costs for the same line items used to determine mobilization costs plus the mobilization costs.

- General site preparation includes the costs to remove and replace existing piles and floating docks in Slip No. 3; remove existing intake and outlet pipes near the OMC outfall to Slip No. 3; furnish and install temporary floating docks; construct a new large boat hoisting facility; install chain link fence around the lagoon, fixation cells, batch plant, and water treatment plant; and construct a roadway to the lagoon and fixation cells.

- Sediment dispersal control includes the costs to furnish, install, and remove the double silt curtain.

- Dredging includes the costs to dredge the sediments and pipe them to the initial solids dewatering basin.

- Localized cofferdam and dewatering includes the costs to install and remove a single sheet pile cofferdam at the localized area; partially dewater the cofferdam; and to remove and replace the sheet pile bulkhead.

- Dredging of deep sand and silt includes the costs to dredge the contaminated sand and silt within the cofferdam.

- Initial solids dewatering--lagoon includes the costs to install and remove lagoon embankment and liner material; the costs to provide, remove, fix, and dispose of volatilization control material; the costs for grading the site after lagoon removal; the costs for site preparation and annual lease of the lagoon site; and the costs for installing and monitoring the air quality sampling stations and the groundwater monitoring wells.

- Water treatment plant and water disposal includes the costs to install and remove a 1,500-gpm water treatment plant and the costs for rental of the water treatment plant.

- Solids removal includes the costs to remove the sediments from the initial solids dewatering basin and transport the solids to the batch plant.

- Fixation includes the costs to install and remove curing cell embankment, liner material, and concrete divider walls; mix the solids with cement; haul fixed solids to the curing cells; and remove fixed solids from the curing cells.

- Transportation and disposal includes the costs to haul the fixed contaminated sediments to a licensed chemical waste landfill.

- Engineering, legal, and administration includes the costs to design the remedial action alternatives, administer the construction, acquire easements, supervise consultant and contractor work, and conduct similar activities. Engineering, legal, and administration costs were estimated at 17 percent of the total costs for all the above line items.

- Contingency was estimated at 30 percent of the total costs for all of the above line items.

Alternative 2D: Dredge-Dewater in Barges-Fix-Dispose

For this alternative, a sediment dispersal control device as described for Slip No. 3--Alternative 2B would be installed across the mouth of Slip No. 3 (Figure 5-1). Sediments with greater than 50 ppm PCBs would be removed by hydraulic dredge and the sediment slurry pumped through a pipeline to the initial solids dewatering barges. Dredging of the deep contaminated sand and silt would be performed as described for Slip No. 3--Alternative 2B.

Solids would be dewatered in ten barges located within the Upper Harbor. Volatilization would be controlled by covering the sediments in the filled barges with organic sludge. The supernatant would be continuously decanted and routed to a 1,500-gpm water treatment plant as described for Slip No. 3--Alternative 2B. After dredging activities are completed, rainwater and leachate water would be treated by the 1,500-gpm water treatment plant for the duration of the dewatering process.

Solids would be removed by backhoe or dragline about 2 months after dredging activities are completed, loaded into trucks and transported to the batch plant. The solids would be fixed as described for Slip No. 3--Alternative 2B to render solids to a nonflowable form, and transported by truck to an approved disposal site.

Barges. Ten barges, each with a storage capacity of 2,000 yd^3, would be required to dewater sediments from Slip No. 3. The barges would be located within the Upper Harbor. The assumed shape and location of the barges are shown on Figure 5-1. Barges would be steel-deck cargo barges with flat bottoms. Each barge would be equipped with submersible pumps to decant the supernatant slurry water.

Curing Cells. The curing cells for this alternative would be the same as required for Slip No. 3--Alternative 2B. The assumed shape and location are shown on Figure 5-1.

Temporary Storage Requirements. Temporary storage requirements for Slip No. 3--Alternative 2D would be the same as for Alternative 2B, except that barges would be used in place of a lagoon. The barges would be moored in the Upper Harbor until they were emptied and decontaminated.

Water Treatment. Slurry water from dredging activities would be treated in the same manner as for Slip No. 3--Alternative 2B.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. These requirements would be the same as those for Slip No. 3--Alternative 2B.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. These items would be the same as those for Slip No. 3--Alternative 2B, except that there would be no disposal of contaminated liner material or uncontaminated lagoon embankment material. However, disposal of material from the decontamination of the barges would be required.

Major Equipment. Major construction equipment and utilities required for Slip No. 3--Alternative 2D include:

- Pile driver
- Hydraulic and clamshell dredges
- Barges
- Backhoe
- Dragline
- Batch plant
- Dump trucks
- Front end loader
- Water treatment plant (see Water Treatment, earlier in this section)

- Electrical service for batch plant
- Electrical lighting
- Water service for contractor's temporary facilities

Special Engineering Considerations. For Slip No. 3--Alternative 2D the following special engineering considerations are presented.

Engineering considerations concerning the dredging of Slip No. 3 include:

- Type of dredge head and rate and pattern of dredging to minimize roiling of sediments
- Type of sediment dispersal control to minimize possibility of contaminating the emergency drinking water supply intake located at the mouth of the harbor
- Stability of sheet piles surrounding Slip No. 3
- Type of cofferdam for dredging of deep contaminated sand and silt near former OMC outfall, and means to prevent failure of existing sheet piling during cofferdam installation and removal

Engineering considerations concerning the initial solids dewatering barges include:

- Method to remove sediments from barges
- Potential loss of contaminated sediments from the barges
- Mooring space for barges in the harbor
- Decontamination of barges

Engineering considerations concerning the sediment dewatering process include:

- Determining the moisture content of sediments to be removed after dewatering
- Controlling volatilization

Engineering considerations concerning fixation include:

- Moisture content of solids to be fixed
- Amount of fixing agent required
- Volume of fixing agent

- Volume of solids to be removed
- Possible interferences of contaminants with the fixing agent
- Time required for curing
- Cost-effectiveness of fixing with portland cement, Locksorb, and/or other fixing agent

Engineering considerations concerning the water treatment process include:

- Determining the cost-effectiveness of replacing activated carbon with Klensorb for soluble PCB removal if the activated carbon should become blinded by the oily nature of PCBs
- Water quality requirements for discharging to the harbor or to a sanitary sewer

Engineering considerations concerning disposal of the PCB contaminated sediments include:

- Ensuring that the sediments have a nonflowable consistency
- Ensuring that moisture or solids do not escape during transport and disposal of the fixed sediments
- Controlling volatilization

Reliability. Slip No. 3--Alternative 2D would remove PCB-contaminated sediments with concentrations greater than 50 ppm from Slip No. 3. The alternative includes dredging, dewatering, water treatment, sediment solidification, and disposal in a licensed chemical waste landfill. This alternative would be effective in abating further PCB contamination of the Waukegan area and Lake Michigan. Slip No. 3--Alternative 2D is considered reliable.

Costs. The Order-of-Magnitude cost estimate for Slip No. 3--Alternative 2D is presented in Table 5-2. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The major elements included in the Table 5-2 line items for Slip No. 3--Alternative 2D are the same as described for Slip No. 3--Alternative 2B, except as noted below:

- General site preparation does not include the costs to install a chain link fence around the lagoon.

Table 5-2

DETAILED COST ESTIMATE
SLIP NO. 3
ALTERNATIVE 2D
DREDGE-DEWATER IN BARGES-FIX-DISPOSE
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 540,000	0	$ 540,000
Health and safety requirements	300,000	0	300,000
General site preparation	280,000	0	280,000
Sediment dispersal control	60,000	0	60,000
Dredging	60,000	0	60,000
Localized cofferdam and dewatering	390,000	$ 60,000	450,000
Dredging of deep sand and silt	20,000	0	20,000
Initial solids dewatering—barges	960,000	10,000	970,000
Water treatment plant and water disposal	1,260,000	10,000	1,270,000
Solids removal	60,000	0	60,000
Fixation	1,580,000	0	1,580,000
Transportation and disposal	710,000	0	710,000
Engineering, legal, and administration	1,060,000	10,000	1,070,000
Subtotal	7,280,000	90,000	7,370,000
Contingency	2,180,000	30,000	2,210,000
Total	$ 9,460,000	$120,000	$ 9,580,000

- Initial solids dewatering--barges includes the costs to rent and decontaminate barges; the costs to provide, remove, fix, and dispose of volatilization control material; and the costs for installing and monitoring the air quality sampling stations.

Alternative 3: Dredge-Dewater in Lagoon-Dispose

For this alternative, a sediment dispersal control device as described for Slip No. 3--Alternative 2B would be installed across the mouth of Slip No. 3 (Figure 5-1). Sediments in excess of 50 ppm PCBs would be removed by hydraulic dredge and the sediment slurry pumped through a pipeline to the initial solids dewatering lagoon. Dredging of the deep contaminated sand and silt would be performed as described for Slip No. 3--Alternative 2B.

Solids would be dewatered in a clay-lined dewatering lagoon constructed on OMC property. The supernatant would be continuously decanted and routed to a 1,500-gpm water treatment plant as described for Slip No. 3--Alternative 2B. After dredging activities are completed, a 200-gpm water treatment plant would treat rainwater and leachate water for the duration of the dewatering process.

After the dredging activities are completed, a RUC (or other channeling device) would be used for channeling the sediments to allow surface drainage. The top layer of solids would be dried by evaporation. The dried solids (typically the top 1 to 2 ft) would be periodically removed with a dragline. The solids would be loaded into lined trucks and transported to an approved disposal site. This process would be repeated about six times over a 2-year period to remove the solids.

Lagoon. The lagoon for this alternative would be the same as that required for Slip No. 3--Alternative 2B. The assumed shape and location of the lagoon are shown on Figure 5-1.

Temporary Storage Requirements. Dredged solids would require temporary storage in the lagoon for dewatering. The solids would be stored until they could be removed in a nonflowable state. This is expected to take about 2 years.

Water Treatment. Slurry water from dredging activities would need to be treated before being discharged. This would be accomplished with the same treatment system as described for Slip No. 3--Alternative 2B, except that rainwater and leachate water would be treated using a 200-gpm treatment plant for about 2 years.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. These requirements would be the same as those for Slip No. 3--Alternative 2B.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. These items would be the same as for Slip No. 3--Alternative 2B, except that about 10,900 yd³ of PCB-contaminated solids and about 5,800 yd³ of contaminated liner material would require disposal. In addition, about 39,000 yd³ of uncontaminated lagoon embankment material would require disposal.

Major Equipment. Major construction equipment and utilities that would be required for Slip No. 3--Alternative 3 include:

- Pile driver
- Hydraulic and clamshell dredges
- Bulldozer
- Compactor
- Scarifier/mixer
- Dragline
- RUC (052)
- Backhoe
- Front end loader
- Dump trucks
- Water treatment plant (see Water Treatment, earlier in this section)
- Electrical lighting
- Water service for contractor's temporary facilities

Special Engineering Considerations. For Slip No. 3--Alternative 3 the following special engineering considerations are presented.

Engineering considerations concerning the dredging of Slip No. 3 include:

- Type of dredge head and rate and pattern of dredging to minimize roiling of sediments
- Type of sediment dispersal control to minimize possibility of contaminating the emergency drinking water supply intake located at the mouth of the harbor

- Stability of sheet piles surrounding Slip No. 3

- Type of cofferdam for dredging of deep contaminated sand and silt near former OMC outfall, and means to prevent failure of existing sheet piling during cofferdam installation and removal

Engineering considerations concerning the initial solids dewatering lagoon include:

- Construction techniques necessary to obtain satisfactory permeabilities in the clay liner

- Durability of the soil-cement

- Determining how much of the lagoon liner material must be disposed of in a licensed PCB disposal facility

Engineering considerations concerning the sediment dewatering process include:

- Determining the moisture content of sediments to be removed after dewatering

- Potential for PCB volatilization during drying

Engineering considerations concerning the water treatment process include:

- Determining the cost-effectiveness of replacing activated carbon with Klensorb for soluble PCB removal if the activated carbon should become blinded by the oily nature of PCBs

- Water quality requirements for discharging to the harbor or to a sanitary sewer

Engineering considerations concerning disposal of the PCB-contaminated sediments include:

- Ensuring that the sediments have a nonflowable consistency

- Ensuring that moisture or solids do not escape during transport and disposal of the sediments

- Controlling volatilization

Reliability. Slip No. 3--Alternative 3 would remove PCB-contaminated sediment with concentrations greater than 50 ppm from Slip No. 3. The alternative includes dredging, dewatering, water treatment, and disposal in a licensed chemical waste landfill. Laboratory tests (004) indicated that the dredged sediments are difficult to dewater. The time required for dewatering is uncertain; it is estimated at 2 years with mechanical dewatering. After dewatering is completed and the solids are removed and disposed of in a licensed chemical waste landfill, this alternative would be considered effective in abating further PCB contamination of the Waukegan area and Lake Michigan. Slip No. 3--Alternative 3 is considered reliable.

Costs. The Order-of-Magnitude cost estimate for Slip No. 3--Alternative 3 is presented in Table 5-3. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The major elements included in Table 5-3 line items for Slip No. 3--Alternative 3 are the same as described for Slip No. 3--Alternative 2B, except as noted below:

- General site preparation does not include the costs to install chain link fence around the fixation cells and batch plant.
- Initial solids dewatering--lagoon does not include the costs to provide, remove, fix, and dispose of volatilization control material.
- Water treatment plant and water disposal includes the costs to install and remove both a 1,500-gpm and a 200-gpm water treatment plant and the costs for rental of the water treatment plants.
- Solids removal includes the costs to remove the sediments from the initial solids dewatering basin and load into trucks.
- Fixation costs would not be required.

UPPER HARBOR

Alternative 2B: Dredge-Dewater in Lagoon-Fix-Dispose

This alternative is the same as Slip No. 3--Alternative 2B, except that dredging of deep contaminated sand and silt would not be required, and the sediment dispersal control device would be installed at the south end of the Upper Harbor (Figure 5-2).

Lagoon. A 118,000-yd³ lagoon would be required to dewater sediments from the Upper Harbor. The assumed shape and location of the proposed lagoon are shown on Figure 5-2. The capacity of the lagoon was based on 2 ft of freeboard and 8 ft of storage. The lagoon would have a clay liner system identical to that proposed for the Slip No. 3--Alternative 2B lagoon.

Table 5-3

DETAILED COST ESTIMATE
SLIP NO. 3
ALTERNATIVE 3
DREDGE-DEWATER IN LAGOON-DISPOSE
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 420,000	0	$ 420,000
Health and safety requirements	230,000	0	230,000
General site preparation	290,000	0	290,000
Sediment dispersal control	60,000	0	60,000
Dredging	60,000	0	60,000
Localized cofferdam and dewatering	390,000	$ 60,000	450,000
Dredging of deep sand and silt	20,000	0	20,000
Initial solids dewatering—Lagoon	1,290,000	40,000	1,330,000
Water treatment plant and water disposal	1,510,000	80,000	1,590,000
Solids removal	30,000	0	30,000
Transportation and disposal	540,000	0	540,000
Engineering, legal, and administration	820,000	30,000	850,000
Subtotal	5,660,000	210,000	5,870,000
Contingency	1,700,000	60,000	1,760,000
Total	$ 7,360,000	$270,000	$ 7,630,000

Curing Cells. The curing cells for this alternative would be the same as those required for Slip No. 3--Alternative 2B. The assumed shape and location are shown on Figure 5-2.

Temporary Storage Requirements. Temporary storage requirements would be the same as those required for Slip No. 3--Alternative 2B.

Water Treatment. Slurry water from dredging activities would be treated in the same manner as for Slip No. 3--Alternative 2B, except that rainwater and leachate water would be treated using a 200-gpm package water treatment plant on an intermittent basis for about 6 months during dewatering.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. These requirements would be the same as those for Slip No. 3--Alternative 2B.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. These items would be the same as those for Slip No. 3--Alternative 2B, except that about 46,400 yd^3 of fixed PCB-contaminated solids, about 25,400 yd^3 of contaminated liner material, and 10,400 yd^3 of contaminated volatilization control material would require disposal. In addition, about 99,300 yd^3 of uncontaminated lagoon embankment material would require disposal.

Major Equipment. Major construction equipment and utilities required for Upper Harbor--Alternative 2B would be the same as those required for Slip No. 3--Alternative 2B, except that a pile driver and clamshell dredge would not be required.

Special Engineering Considerations. For Upper Harbor--Alternative 2B the following special engineering considerations are presented.

Engineering considerations concerning the dredging of the Upper Harbor include:

- Type of dredge head and rate and pattern of dredging to minimize roiling of sediments
- Type of sediment dispersal control to minimize possibility of contaminating the emergency drinking water supply intake located at the mouth of the harbor
- Stability of sheet piles surrounding the Upper Harbor
- Contaminated riprap at the bottom of the sheet piles

All other engineering considerations for this alternative would be the same as those for Slip No. 3--Alternative 2B.

Reliability. Upper Harbor--Alternative 2B would remove PCB-contaminated sediments with concentrations greater than 50 ppm from the Upper Harbor. The alternative includes dredging, dewatering, water treatment, sediment solidification, and disposal in a licensed chemical waste landfill. This alternative would be effective in abating further PCB contamination of the Waukegan area and Lake Michigan. Upper Harbor--Alternative 2B is considered reliable.

Costs The Order-of-Magnitude cost estimate for Upper Harbor--Alternative 2B is presented in Table 5-4. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The major elements included in Table 5-4 line items for Upper Harbor--Alternative 2B are the same as described for Slip No. 3--Alternative 2B, except as noted below:

- General site preparation includes the costs to install a chain link fence around the lagoon, fixation cells, batch plant, and water treatment plant and the costs to construct a roadway to the lagoon and curing cells.
- A localized cofferdam and dewatering would not be required.
- Dredging of deep contaminated sand and silt would not be required.
- Water treatment plant and water disposal includes the costs to install and remove both a 1,500-gpm and a 200-gpm water treatment plant and the costs for rental of the water treatment plants.

Alternative 3: Dredge-Dewater in Lagoon-Dispose

This alternative is the same as Slip No. 3--Alternative 3, except that dredging of deep contaminated sand and silt would not be required and the sediment dispersal control device would be installed at the south end of the Upper Harbor (Figure 5-2).

Lagoon. The lagoon required for this alternative would be the same as that required for Upper Harbor--Alternative 2B. The assumed shape and location of the lagoon are shown on Figure 5-2. The lagoon would have a clay liner system identical to that proposed for the Slip No. 3--Alternative 2B lagoon.

Temporary Storage Requirements. Dredged solids would require temporary storage in the lagoon for dewatering. The solids would be stored until they can be removed in a nonflowable state. This is expected to take about 2 years.

Table 5-4

DETAILED COST ESTIMATE
UPPER HARBOR
ALTERNATIVE 2B
DREDGE-DEWATER IN LAGOON-FIX-DISPOSE
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 1,400,000	0	$ 1,400,000
Health and safety requirements	770,000	0	770,000
General site preparation	80,000	0	80,000
Sediment dispersal control	80,000	0	80,000
Dredging	220,000	0	220,000
Initial solids dewatering-lagoon	5,250,000	$ 10,000	5,260,000
Water treatment plant and water disposal	1,530,000	180,000	1,710,000
Solids removal	240,000	0	240,000
Fixation	4,250,000	0	4,250,000
Transportation and disposal	2,320,000	0	2,320,000
Engineering, legal, and administration	2,740,000	30,000	2,770,000
Subtotal	18,880,000	220,000	19,100,000
Contingency	5,660,000	70,000	5,730,000
Total	$24,540,000	$290,000	$24,830,000

Water Treatment. Water treatment requirements for this alternative would be the same as for Slip No. 3--Alternative 2B, except that rainwater and leachate water would be treated using a 200-gpm package water treatment plant for about 2 years.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. These requirements would be the same as those for Slip No. 3--Alternative 2B.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. These items would be the same as for Slip No. 3--Alternative 3, except that about 35,700 yd^3 of PCB-contaminated solids and about 25,400 yd^3 of contaminated liner material would require disposal. In addition, about 99,300 yd^3 of uncontaminated lagoon embankment material would require disposal.

Major Equipment. Major construction equipment and utilities required for Upper Harbor--Alternative 3 would be the same as those required for Slip No. 3--Alternative 3.

Special Engineering Considerations. For Upper Harbor--Alternative 3 the following special engineering considerations are presented.

Engineering considerations concerning the dredging of the Upper Harbor include:

- Type of dredge head and rate and pattern of dredging to minimize roiling of sediments
- Type of sediment dispersal control to minimize possibility of contaminating the emergency drinking water supply intake located at the mouth of the harbor
- Stability of sheet piles surrounding the Upper Harbor
- Contaminated riprap at the bottom of the sheet piles

All other engineering considerations for this alternative would be the same as those for Slip No. 3--Alternative 3.

Reliability. Upper Harbor--Alternative 3 would remove PCB-contaminated sediments with concentrations greater than 50 ppm from the Upper Harbor. The alternative includes dredging, dewatering, water treatment, and disposal in a licensed chemical waste landfill. Laboratory tests (004) indicated that the dredged sediments are difficult to dewater. The time required for dewatering is uncertain. After dewatering is completed and the solids are removed and disposed of in a licensed chemical waste landfill, this alternative would be effective in abating further PCB contamination of the Waukegan area and Lake Michigan. Upper Harbor--Alternative 3 is considered reliable.

Costs. The Order-of-Magnitude cost estimate for Upper Harbor--Alternative 3 is presented in Table 5-5. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The major elements included in Table 5-5 line items for Upper Harbor--Alternative 3 are the same as described for Slip No. 3--Alternative 2B, except as noted below:

- General site preparation includes the costs to install a chain link fence around the lagoon and water treatment plant and the costs to construct a roadway to the lagoon.
- A localized cofferdam and dewatering would not be required.
- Dredging of deep contaminated sand and silt would not be required.
- Initial solids dewatering--lagoon does not include the costs to provide, remove, fix, and dispose of volatilization material.
- Water treatment plant and water disposal includes the costs to install and remove both a 1,500-gpm and a 200-gpm water treatment plant and the costs for rental of the water treatment plants.
- Solids removal includes the costs to remove sediments from the initial solids dewatering basin and load into trucks.
- Fixation would not be required.

SLIP NO. 3 AND UPPER HARBOR

Alternative 6A: Contain-Dredge-Cap

A sediment dispersal control device, consisting of a double silt curtain or sheet piling, would be installed at the south end of the Upper Harbor (Figure 5-3). Then a cofferdam would be constructed near the north end of the Upper Harbor to close off Slip No. 3. A slurry wall extending into the glacial till would be constructed inside the cofferdam and around the entire perimeter of the containment area.

Dredged sediments with greater than 50 ppm PCBs from the Upper Harbor would be placed within the contained area. Alternative 6A would control almost 100 percent of all the

Table 5-5

DETAILED COST ESTIMATE
UPPER HARBOR
ALTERNATIVE 3
DREDGE-DEWATER IN LAGOON-DISPOSE
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 770,000	0	$ 770,000
Health and safety requirements	420,000	0	420,000
General site preparation	80,000	0	80,000
Sediment dispersal control	80,000	0	80,000
Dredging	220,000	0	220,000
Initial solids dewatering-lagoon	3,830,000	$ 40,000	3,870,000
Water treatment plant and water disposal	1,590,000	80,000	1,670,000
Solids removal	110,000	0	110,000
Transportation and disposal	1,780,000	0	1,780,000
Engineering, legal, and administration	1,510,000	20,000	1,530,000
Subtotal	10,390,000	140,000	10,530,000
Contingency	3,120,000	40,000	3,160,000
Total	$13,510,000	$180,000	$13,690,000

PCBs now found in Slip No. 3 and Upper Harbor sediment. Supernatant would be continuously decanted and routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the harbor or to a sanitary sewer. After completion of dredging, a layer of filter fabric, a 1-ft-thick layer of sand with a drainage system, and a 3-ft-thick compacted clay cap would cover the dredged muck. Five feet of fill over the clay would serve as a surcharge. Water collected from the drainage system would be treated as described above. Slip No. 3 would be left permanently filled. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

After completion of all dredging activities, the water treatment plant would be removed and a new basin would be constructed to replace Slip No. 3. After settlement of the muck in Slip No. 3 is complete, the excess surcharge material would be removed and the area paved.

Containment/Encapsulation. A slurry wall would be constructed to completely encircle Slip No. 3 and the northwest portion of the Upper Harbor. The proposed containment area is shown on Figure 5-3. The existing glacial till beneath the site would be relied upon to act as a bottom seal. An impervious cap consisting of 3 ft of compacted clay covered by asphaltic concrete paving would be used to cover the top of the filled-in containment area.

Temporary Storage Requirements. No temporary storage would be required. This alternative does, however, require long-term, onsite storage.

Water Treatment. Harbor water from the containment area and slurry water from dredging activities in the Upper Harbor would need to be treated before discharge. Treatment would be the same as that described for Slip No. 3--Alternative 2B, except that rainwater and leachate water would be treated using a 200-gpm package water treatment plant for about 1 year during dewatering and densification.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. In Alternative 6A, PCBs are contained onsite. Groundwater monitoring wells would be required to determine whether PCBs were migrating from the containment area. Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external water levels so that any leakage is into the containment area. The area would be capped. The cap would need to be properly maintained so that it would continue to be an impermeable barrier to surface water.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. For Alternative 6A, no PCB-contaminated solids would require offsite disposal. USEPA waivers in accordance with 40 CFR 761 under TSCA would be required to leave the PCBs onsite. About 46,600 yd^3 of sediments containing about 310,000 lb of PCBs would be contained in-place in the containment area.

Major Equipment. Major construction equipment and utilities required for Alternative 6A include:

- Pile driver
- Hydraulic dredge
- Slurry trench excavator
- Slurry mixing equipment
- Bulldozer
- Compactor
- Front end loader
- Dump trucks
- Paving equipment
- Water treatment plant (see Water Treatment, earlier in this section)
- Electrical lighting
- Water services for contractor's temporary facilities

Special Engineering Considerations. For Alternative 6A, the following special engineering considerations are presented.

Engineering considerations concerning constructing the cofferdam and slurry wall include:

- Location, type, and dimensions of cofferdam sheet piles
- Type and method of placement of cofferdam fill
- Depth and construction techniques for the slurry wall to ensure its integrity
- The effects of PCBs on slurry walls

Engineering considerations concerning the dredging of the Upper Harbor include:

- Type of dredge head and rate and pattern of dredging to minimize roiling of sediments

- Type of sediment dispersal control to minimize possibility of contaminating the emergency drinking water supply intake located at the mouth of the harbor

- Stability of sheet piles surrounding the Upper Harbor

- Contaminated riprap at the bottom of the sheet piles

Engineering considerations concerning the clay cap include:

- Selection of cap material and determination of correct placement methods

- Duration of surcharge

- Design of asphaltic concrete pavement for prolonged service as a membrane

Engineering considerations concerning the water treatment process include:

- Determining the cost-effectiveness of replacing activated carbon with Klensorb for soluble PCB removal if the activated carbon should become blinded by the oily nature of PCBs

- Water quality requirements for discharging to the harbor or to a sanitary sewer

- Need for treatment of water removed from the drainage layer beneath the clay cap

Reliability. Alternative 6A would not dispose of PCB-contaminated solids offsite but would contain and cap Slip No. 3 and the northwest portion of the Upper Harbor. There is no data on long-term reliability of this alternative. Groundwater fluctuations may cause drying or cracking of the slurry walls or the clay cap. Freezing and thawing action may also cause deterioration of the slurry walls and cap. The underlying glacial till may have cracks, fissures, or pockets of more permeable material through which PCBs could migrate. The containment area would be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment can be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry wall below the frostline.

- Use of a flexible membrane for the cap could be considered for more freedom in site grading.

- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination of the Waukegan area and Lake Michigan. Alternative 6A is considered reliable.

Costs. The Order-of-Magnitude cost estimate for Alternative 6A is presented in Table 5-6. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The mobilization; health and safety requirements; engineering, legal, and administration; and contingency costs included in Table 5-6 for Slip No. 3 and Upper Harbor--Alternative 6A are the same as described for Slip No. 3--Alternative 2B. A description of the major elements included in the remaining Table 5-6 line items follows:

- General site preparation includes the costs to remove and replace existing piles and floating docks in Slip No. 3, remove existing intake and outlet pipes near OMC's Slip No. 3 outfall, furnish and install temporary floating docks, construct a new large boat hoisting facility, and install chain link fence around the water treatment plant.

- Sediment dispersal control includes the costs to furnish, install, and remove the double silt curtain.

- Cofferdam includes the costs for the fill at the base of the sheet piling and the costs for the sheet piling.

- Slurry wall includes the costs to install a soil-bentonite slurry wall.

- Dredging Upper Harbor includes the costs to dredge the sediments and pipe them to the containment area.

- Water treatment plant and water disposal includes the costs to install and remove both a 1,500-gpm and a 200-gpm water treatment plant and the costs for rental of the water treatment plants.

- Clay cap and surcharge includes the costs to provide and install the filter fabric, drainage system, clay cap, and surcharge.

Table 5-6

DETAILED COST ESTIMATE
SLIP NO. 3 AND UPPER HARBOR
ALTERNATIVE 6A
CONTAIN-DREDGE-CAP
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 510,000	0	$ 510,000
Health and safety requirements	280,000	0	280,000
General site preparation	310,000	0	310,000
Sediment dispersal control	40,000	0	40,000
Cofferdam	710,000	0	710,000
Slurry wall	550,000	0	550,000
Dredging Upper Harbor sediments	220,000	0	220,000
Water treatment plant and water disposal	1,560,000	$ 20,000	1,580,000
Clay cap and surcharge	340,000	0	340,000
Construct new harbor area	1,210,000	0	1,210,000
Monitoring (wells)	30,000	200,000	230,000
Surcharge removal and paving	130,000	0	130,000
Engineering, legal, and administration	1,000,000	40,000	1,040,000
Subtotal	6,890,000	260,000	7,150,000
Contingency	2,070,000	80,000	2,150,000
Total	$ 8,960,000	$340,000	$ 9,300,000

- Construct new harbor includes the costs to remove existing sheet piling, install new steel sheet piling, excavate material and haul offsite, and the costs for the land.

- Monitoring (wells) includes the costs for installing and monitoring the groundwater monitoring wells.

- Surcharge removal and paving includes the cost to remove and haul off the surcharge remaining above grade after settlement of the containment area and the cost to pave the containment area.

Alternative 6B: Contain-Dredge Part of Upper Harbor-Car

A sediment dispersal control device, consisting of a double silt curtain or sheet piling, would be installed across the middle of the Upper Harbor (Figure 5-4). Then a cofferdam would be constructed near the east end of Slip No. 3 to close it off. A slurry wall extending into the glacial till would be constructed inside the cofferdam and around the entire perimeter of the containment area.

Dredged sediments with greater than 50 ppm PCBs from the eastern portion of Slip No. 3 and part of the Upper Harbor would be placed within the contained area. This alternative would not address approximately 25,500 yd^3 of sediments containing 3,100 lb of PCBs with concentrations between 50 and 150 ppm in the Upper Harbor. Alternative 6B, however, would control 99 percent of all the PCBs now found in Slip No. 3 and Upper Harbor sediments. Supernatant would be continuously decanted and routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the harbor or to a sanitary sewer. After completion of dredging, a layer of filter fabric, a 1-ft-thick layer of sand with a drainage system, and a 3-ft-thick compacted clay cap would cover the dredged muck. Five feet of fill over the clay would serve as a surcharge. Water collected from the drainage system would be treated as described above. Slip No. 3 would be left permanently filled. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

After completion of all dredging activities, the water treatment plant would be removed and a new basin would be constructed to replace Slip No. 3. After settlement of the muck in Slip No. 3 is complete, the excess surcharge material would be removed and the area paved.

Containment/Encapsulation. A slurry wall would be constructed to completely encircle the containment area. The proposed containment area is shown on Figure 5-4. The existing glacial till beneath the site would be relied upon to act as a bottom seal. An impervious cap consisting of 3 ft of compacted clay covered by asphaltic concrete paving would be used to cover the top of the filled-in containment area.

Temporary Storage Requirements. No temporary storage would be required. This alternative does, however, require long-term, onsite storage.

Water Treatment. Harbor water from the containment area and slurry water from dredging activities in the Upper Harbor would need to be treated before discharge. Treatment would be the same as that described for Slip No. 3--Alternative 2B, except that rainwater and leachate water would be treated using a 200-gpm package water treatment plant for about 1 year during dewatering and densification.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. In Alternative 6B, PCBs are contained onsite. Groundwater monitoring wells would be required to determine whether PCBs were migrating from the containment area. Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external water levels so that any leakage is into the containment area. The area would be capped. The cap would need to be properly maintained so that it would continue to be an impermeable barrier to surface water.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. For Alternative 6B, no PCB-contaminated solids would require offsite disposal. USEPA waivers in accordance with 40 CFR 761 under TSCA would be required to leave the PCBs onsite. About 21,100 yd^3 of sediments containing about 306,900 lb of PCBs would be contained in-place in the containment area.

Major Equipment. Major construction equipment and utilities required for Alternative 6B would be the same as those required for Alternative 6A.

Special Engineering Considerations. Special engineering considerations for Alternative 6B would be the same as those required for Alternative 6A.

Reliability. Alternative 6B would not dispose of PCB-contaminated solids offsite but would contain and cap the western portion of Slip No. 3. There is no data on long-term reliability of this alternative. Groundwater fluctuations may cause drying or cracking of the slurry walls or the clay cap. Freezing and thawing action may also cause deterioration of the slurry walls and cap. The underlying glacial till may have cracks, fissures, or pockets of more permeable material through which PCBs could migrate. The containment area would be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment can be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry wall below the frostline.

- Use of a flexible membrane for the cap could be considered for more freedom in site grading.

- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination of the Waukegan area and Lake Michigan. Alternative 6B is considered reliable.

Costs. The Order-of-Magnitude cost estimate for Alternative 6B is presented in Table 5-7. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The mobilization; health and safety requirements; engineering, legal, and administration; and contingency costs included in Table 5-7 for Slip No. 3 and Upper Harbor--Alternative 6B are the same as described for Slip No. 3--Alternative 2B. A description of the major elements included in the remaining Table 5-7 line items follows:

- General site preparation includes the costs to remove and replace existing piles and floating docks in Slip No. 3, remove existing intake and outlet pipes near OMC's Slip No. 3 outfall, furnish and install temporary floating docks, construct a new large boat hoisting facility, and install chain link fence around the water treatment plant.

- Sediment dispersal control includes the costs to furnish, install, and remove the double silt curtain.

- Cofferdam includes the costs for the fill at the base of the sheet piling and the costs for the sheet piling.

- Slurry wall includes the costs to install a soil-bentonite slurry wall.

Table 5-7

DETAILED COST ESTIMATE
SLIP NO. 3 AND UPPER HARBOR
ALTERNATIVE 6B
CONTAIN-DREDGE PART OF UPPER HARBOR-CAP
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 330,000	0	$ 330,000
Health and safety requirements	180,000	0	180,000
General site preparation	290,000	0	290,000
Sediment dispersal control	40,000	0	40,000
Cofferdam	160,000	0	160,000
Slurry wall	290,000	0	290,000
Dredging Upper Harbor sediments	90,000	0	90,000
Water treatment plant and water disposal	1,560,000	$ 20,000	1,580,000
Clay cap and surcharge	130,000	0	130,000
Construct new harbor area	650,000	0	650,000
Monitoring (wells)	20,000	200,000	220,000
Surcharge removal and paving	50,000	0	50,000
Engineering, legal, and administration	640,000	40,000	680,000
Subtotal	4,430,000	260,000	4,690,000
Contingency	1,330,000	80,000	1,410,000
Total	$ 5,760,000	$340,000	$ 6,100,000

- Dredging Upper Harbor includes the costs to dredge the sediments and pipe them to the containment area.

- Water treatment plant and water disposal includes the costs to install and remove both a 1,500-gpm and a 200-gpm water treatment plant and the costs for rental of the water treatment plants.

- Clay cap and surcharge includes the costs to provide and install the filter fabric, drainage system, clay cap, and surcharge.

- Construct new harbor includes the costs to remove existing sheet piling, install new steel sheet piling, excavate material and haul offsite, and the costs for the land.

- Monitoring (wells) includes the costs for installing and monitoring the groundwater monitoring wells.

- Surcharge removal and paving includes the costs to remove and haul off the surcharge remaining above grade after settlement of the containment area and to pave the containment area.

Subalternative I: Select Excavation

This subalternative would be used only in conjunction with Alternatives 6A or 5B. "Hot spots" would be removed by clamshell dredging, fixed, and disposed of offsite. "Hot spots" consist of 5,700 yd^3 of deep contaminated sand and silt near the former OMC outfall and silt in the western portion of Slip No. 3 with PCB concentrations in excess of 10,000 ppm. Dredging of the deep contaminated sand and silt would be performed inside a single sheet pile cofferdam. Subalternative I would remove and dispose of offsite 92 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor area (286,500 lb of PCBs). The solids would be transported to the batch plant and fixed by adding portland cement, Locksorb, or another fixing agent to hydrate the excess water. The mix would then be transported to curing cells. The fixed solids would be cured until they were nonflowable. This is expected to take about 1 day. The fixed solids would be removed from the curing cells by front end loaders for transportation by truck to an approved disposal site.

Curing Cells. The curing cells for this alternative would be the same as required for Slip No. 3--Alternative 2B. The assumed shape and location are shown on Figures 5-3 and 5-4.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. These items would be the same as those for Slip No. 3--Alternative 2B, except about 7,100 yd³ of fixed PCB-contaminated solids would require disposal. For Alternative 6A in conjunction with Subalternative I, about 40,900 yd³ of sediments containing 23,500 lb of PCBs would be contained in-place in the containment area. For Alternative 6B in conjunction with Subalternative I, about 15,400 yd³ of sediment containing 20,400 lb of PCBs would be contained in-place in the containment area.

Major Equipment. Major construction equipment and utilities required for Subalternative I include:

- Pile driver
- Clamshell dredge
- Backhoe
- Batch plant
- Dump trucks
- Front end loader
- Electrical service for batch plant
- Electrical lighting
- Water service for contractor's temporary facilities

Special Engineering Considerations. For Subalternative I, the following special engineering considerations are presented.

Engineering considerations concerning dredging of Slip No. 3 include:

- Type of cofferdam for dredging of deep contaminated sand and silt near former OMC outfall, and means to prevent failure of existing sheet piling during cofferdam installation and removal

Engineering considerations concerning fixation include:

- Moisture content of solids to be fixed
- Amount of fixing agent required
- Volume of fixing agent
- Volume of solids to be removed

- Possible interferences of contaminants with the fixing agent

- Time required for curing

- Cost effectiveness of fixing with portland cement, Locksorb, and/or other fixing agent

Engineering considerations concerning disposal of the PCB-contaminated sediments include:

- Ensuring that the sediments have a nonflowable consistency

- Ensuring that moisture or solids do not escape during transport and disposal of the fixed sediments

- Controlling volatilization

Reliability. Slip No. 3 and Upper Harbor--Subalternative I would remove and dispose of PCB-contaminated sediments with concentrations greater than 10,000 ppm from Slip No. 3. Subalternative I includes dredging, sediment solidification, and disposal in a licensed chemical waste landfill. This subalternative would be effective in abating further PCB contamination of the Waukegan area and Lake Michigan. Subalternative I is considered reliable.

Costs. The Order-of-Magnitude cost estimate for Slip No. 3 and Upper Harbor--Subalternative I is presented in Table 5-8. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The mobilization; health and safety requirements; engineering, legal, and administration; and contingency costs included in Table 5-8 for Slip No. 3 and Upper Harbor--Subalternative I are the same as described for Slip No. 3--Alternative 2B. A description of the major elements included in the remaining Table 5-8 line items follows:

- Localized cofferdam and dewatering includes the costs to install and remove a single sheet pile cofferdam at the localized area; partially dewater the cofferdam; and remove and replace the sheet pile bulkhead.

- Dredging of deep sand and silt includes the costs to dredge the contaminated sand and silt within the cofferdam and the "hot spots" outside the cofferdam.

Table 5-8

DETAILED COST ESTIMATE
SLIP NO. 3 AND UPPER HARBOR
SUBALTERNATIVE I
SELECT EXCAVATION
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 170,000	0	$ 170,000
Health and safety requirements	100,000	0	100,000
Localized cofferdam and dewatering	390,000	$ 60,000	450,000
Dredging of deep sand and silt	30,000	0	30,000
Solids removal	20,000	0	20,000
Fixation	940,000	0	940,000
Transportation and disposal	360,000	0	360,000
Engineering, legal, and administration	340,000	10,000	350,000
Subtotal	2,350,000	70,000	2,420,000
Contingency	710,000	20,000	730,000
Total	$ 3,060,000	$ 90,000	$ 3,150,000

- Solids removal includes the costs to transport the solids to the batch plant.

- Fixation includes the costs to install and remove curing cell embankment, liner material, and concrete divider walls; mix the solids with cement; haul fixed solids to the curing cells; and remove fixed solids from the curing cells.

- Transportation and disposal includes the costs to haul the contaminated material to an approved chemical waste landfill.

NORTH DITCH/PARKING LOT AREA

Alternative 1: Excavate-Dispose

A bypass would be constructed to divert surface water flow around the highly contaminated areas of the Crescent Ditch and Oval Lagoon (Figure 5-5). The bypass would outfall directly into Lake Michigan. Construction would then begin on a structural slurry wall (or other structural support system) around the Crescent Ditch and a nonstructural slurry wall around the Oval Lagoon. A nonstructural slurry wall would be constructed around the deep contamination in the Parking Lot area. The soils would be dewatered using well points and pumps. Well water would be routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the lake or to a sanitary sewer.

Soils with greater than 50 ppm PCBs would be excavated by backhoe or front end loader and placed in lined trucks for transport to an approved disposal site. The excavated areas would be backfilled.

North Ditch Bypass. A gravity pipeline bypass would be constructed to divert surface water flow around the highly contaminated areas, the Crescent Ditch and Oval Lagoon. The location of the proposed bypass is shown on Figure 5-5. This bypass would collect drainage from the 36-inch-diameter storm drain (that flows north at the west edge of OMC's property), from OMC plant roof drains, and from regraded areas north and south of the Crescent Ditch. The bypass would discharge to Lake Michigan. It would be constructed south of the sheet piling just north of the east-west portion of the North Ditch. The Parking Lot area would be regraded to divert surface water flow to catch basins.

An area approximately 15 ft deep by 25 ft wide of PCB-contaminated soil from the North Ditch would be excavated and disposed of in a licensed chemical waste landfill. Before excavation, the existing sheet piling (along the north side of the North

Ditch) would be fitted with extensions and driven an estimated 5 to 8 ft, penetrating into the confining clay layer. Additional sheet piling would be driven on the south side of the North Ditch. The area would then be dewatered. After excavation, the area would be backfilled and the gravity pipeline installed.

Temporary Storage Requirements. North Ditch/Parking Lot Area--Alternative 1 would not require any temporary storage of solids before disposal.

Water Treatment. Groundwater removed from the areas to be excavated may need to be treated before it can be discharged back into the environment. The water treatment process would be the same used in Slip No. 3--Alternative 2B. The groundwater would be pumped directly to a 200-gpm package water treatment plant for treatment and discharge to Lake Michigan or to a sanitary sewer. The treatment plant would be used for about 7 months.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. In North Ditch/Parking Lot Area--Alternative 1, the proposed action removes the PCBs from the project site and disposes of them in a licensed chemical waste landfill. Therefore, there are no onsite operation, maintenance, or monitoring requirements after completing the proposed remedy.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. These items would be the same as for Slip No. 3--Alternative 2B, except that approximately 175,800 yd^3 of PCB-contaminated solids would require disposal. In addition, a permit to operate construction equipment under the existing powerline would be required.

Major Equipment. Major construction equipment and utilities required for North Ditch/Parking Lot Area--Alternative 1 include:

- Pile driver
- Backhoe
- Front end loader
- Dump trucks
- Construction dewatering equipment
- Slurry trench excavator
- Slurry mixing equipment

- Water treatment plant (see Water Treatment, earlier in this section)

- Electrical lighting

- Water service for contractor's temporary facilities

Special Engineering Considerations. For North Ditch/ Parking Lot Area--Alternative 1 the following special engineering considerations are presented.

Engineering considerations concerning construction dewatering (groundwater) include:

- Rate and duration of well point pumping before satisfactory moisture content in soils is obtained

Engineering considerations concerning excavation include:

- Type of structural walls for excavation

- Possible contamination behind sheet piles adjacent to the North Ditch

- Controlling volatilization

Engineering considerations concerning the water treatment process include:

- Determining the cost-effectiveness of replacing activated carbon with Klensorb for soluble PCB removal if the activated carbon should become blinded by the oily nature of PCBs

- Water quality requirements for discharging to the lake or to a sanitary sewer

Engineering considerations concerning disposal of the PCB-contaminated soils include:

- Ensuring that the soils have a nonflowable consistency

- Ensuring that moisture or solids do not escape during transport and disposal of the soils

- Controlling volatilization

Reliability. North Ditch/Parking Lot Area--Alternative 1 would remove PCB-contaminated solids with concentrations greater than 50 ppm from the North Ditch/Parking Lot area. The alternative includes groundwater dewatering and treatment, and soil excavation and disposal in a licensed chemical waste landfill. This alternative is effective in abating further PCB contamination of the Waukegan area and Lake Michigan. North Ditch/Parking Lot Area--Alternative 1 is considered reliable.

- Costs. The Order-of-Magnitude cost estimates for North Ditch/Parking Lot Area--Alternative 1 are presented in Tables 5-9 and 5-10, for the North Ditch area and Parking Lot area, respectively. These estimates were developed as described for Slip No. 3--Alternative 2B.

The mobilization; health and safety requirements; engineering, legal, and administration; and contingency costs included in Table 5-9 for North Ditch--Alternative 1 are the same as described for Slip No. 3--Alternative 2B. A description of the major elements included in the remaining Table 5-9 line items follows:

- General site preparation includes the costs to remove and relocate the chain link fence and railroad tracks, remove and replace pavement, reroute the 10-inch-diameter sanitary sewer, relocate the propane tanks, underpin the elevated water tank, and install new manholes for rerouting the sewer.

- Bypass North Ditch includes the costs to install the pipeline around the Crescent Ditch and Oval Lagoon areas and through the east-west portion of the North Ditch.

- Dewatering includes the costs to install and remove well points, pipes, and pumps for dewatering the material; install slurry walls; and dispose of contaminated material from the slurry wall excavation.

- Water treatment plant and water disposal includes the costs to install and remove a 200-gpm water treatment plant and the costs for rental of the water treatment plant.

- Excavation and backfilling includes the costs to excavate contaminated material and place the material in trucks and the costs to backfill excavated areas with imported materials.

- Transportation and disposal includes the costs to haul the contaminated material to a licensed chemical waste landfill.

The mobilization; health and safety requirements; engineering, legal, and administration; and contingency costs included in Table 5-10 for Parking Lot--Alternative 1 are the same as

Table 5-9

DETAILED COST ESTIMATE
NORTH DITCH
ALTERNATIVE 1
EXCAVATE-DISPOSE
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 940,000	0	$ 940,000
Health and safety requirements	520,000	0	520,000
General site preparation	100,000	0	100,000
Bypass North Ditch	4,720,000	0	4,720,000
Dewatering	1,660,000	$ 20,000	1,680,000
Water treatment plant and water disposal	170,000	20,000	190,000
Excavation and backfilling	510,000	0	510,000
Transportation and disposal	2,290,000	0	2,290,000
Engineering, legal, and administration	1,860,000	10,000	1,870,000
Subtotal	12,770,000	30,000	12,820,000
Contingency	3,830,000	20,000	3,850,000
Total	$16,600,000	$70,000	$16,670,000

Table 5-10

DETAILED COST ESTIMATE
PARKING LOT
ALTERNATIVE 1
EXCAVATE-DISPOSE
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 710,000	0	$ 710,000
Health and safety requirements	390,000	0	390,000
General site preparation	330,000	0	330,000
Dewatering	380,000	$ 10,000	390,000
Water treatment plant and water disposal	10,000	10,000	20,000
Excavation and backfilling	1,170,000	0	1,170,000
Transportation and disposal	5,250,000	0	5,250,000
Engineering, legal, and administration	1,400,000	10,000	1,410,000
Subtotal	9,640,000	30,000	9,670,000
Contingency	2,890,000	10,000	2,900,000
Total	$12,530,000	$40,000	$12,570,000

described for Slip No. 3--Alternative 2B. A description of the major elements included in the remaining Table 5-10 line items follows:

- General site preparation includes the costs to remove and replace pavement, reroute a 12-inch-diameter high-pressure gas line, and relocate a light pole.

- Dewatering includes the costs to install and remove well points, pipes, and pumps required for dewatering of the material; install slurry walls; and dispose of the contaminated material from the slurry wall excavation.

- Water treatment and water disposal includes the costs for rental of the water treatment plant.

- Excavation and backfilling includes the costs to excavate the contaminated material and place it in trucks and the costs to backfill the excavated areas with imported materials.

- Transportation and disposal includes the costs to haul the contaminated material to a licensed chemical waste landfill.

Alternative 3: Excavate-Fix-Dispose

A bypass would be constructed as described for North Ditch/Parking Lot Area--Alternative 1 (Figure 5-5). The excavation area would be dewatered within a slurry wall, and the well water would be treated as described for North Ditch/Parking Lot Area--Alternative 1. Soils with greater than 50 ppm PCBs would be excavated with a backhoe or front end loader and placed in trucks to be transported to the batch plant. The soil would then be fixed with portland cement, Locksorb, or another fixing agent to hydrate the excess water. The fixed soil would then be transported to the curing cells. The fixed solids would be cured until they were nonflowable. The fixed solids would be removed from the curing cells by front end loaders for transport by truck to an approved disposal site.

North Ditch Bypass. The bypass would be the same as that required for North Ditch/Parking Lot Area--Alternative 1. The location of the proposed bypass is shown on Figure 5-5.

Curing Cells. The curing cells for this alternative would be the same as those required for Slip No. 3--Alternative 2B. The assumed shape and location are shown on Figure 5-5.

Temporary Storage Requirements. In North Ditch/Parking Lot Area--Alternative 3, excavated solids that are too wet to be transported to a licensed chemical waste landfill would require fixation before disposal. Fixation is expected to require 1 day of temporary storage for curing.

Water Treatment. Water treatment requirements would be the same as those for North Ditch/Parking Lot Area--Alternative 1.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. These requirements are the same as those for North Ditch/Parking Lot Area--Alternative 1.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. These items would be the same as those for North Ditch/Parking Lot Area--Alternative 1, except that approximately 219,800 yd^3 of fixed PCB-contaminated solids would require disposal.

Major Equipment. Major construction equipment and utilities required for North Ditch/Parking Lot Area--Alternative 3 would be the same as those required for North Ditch/Parking Lot Area--Alternative 1, except that a batch plant and electrical services for the batch plant would also be required.

Special Engineering Considerations. For North Ditch/Parking Lot Area--Alternative 3, special engineering considerations would be the same as those for North Ditch/Parking Lot Area--Alternative 1, with the following additional engineering considerations concerning fixation:

- Moisture content of solids to be fixed
- Amount of fixing agent required
- Volume of fixing agent
- Volume of solids to be removed
- Possible interference of contaminants with the fixing agent
- Time required for curing
- Cost-effectiveness of fixing with portland cement, Locksorb, and/or other fixing agent

Reliability. North Ditch/Parking Lot Area--Alternative 3 would remove PCB-contaminated soil with concentrations greater than 50 ppm from the North Ditch/Parking Lot area. The alternative includes groundwater dewatering and treatment, soil excavation, fixation of excess water in the soil, and solids disposal in a licensed chemical waste landfill. This alternative would be effective in abating further PCB contamination of the Waukegan area and Lake Michigan. North Ditch/Parking Lot Area--Alternative 3 is considered reliable.

Costs. The Order-of-Magnitude cost estimates for North Ditch/Parking Lot Area--Alternative 3 are presented in Tables 5-11 and 5-12 for the North Ditch area and Parking Lot area, respectively. These cost estimates were developed as described for Slip No. 3--Alternative 2B.

The major elements included in the Table 5-11 line items for North Ditch--Alternative 3 are the same as described for North Ditch--Alternative 1, except as noted below:

- Fixation includes the costs to mix the solids with cement, haul fixed solids to the curing cells, and remove the fixed solids from the curing cells.

The description of the major elements included in the Table 5-12 line items for Parking Lot--Alternative 3 would be the same as described for Parking Lot--Alternative 1, except as follows:

- Fixation includes the costs to mix the solids with cement, haul fixed solids to the curing cells, and remove fixed solids from the curing cells.

Alternative 4: Contain-Cap (Parking Lot Area Only)

A slurry wall extending down into the underlying glacial till would be constructed around the Parking Lot to control movement of contaminated materials (Figure 5-6). This alternative would control about 36 percent of all the PCBs now found in the North Ditch/Parking Lot area. The site would be capped with a 3-ft compacted clay layer to seal in the contaminated soils and reduce infiltration of surface water. The area would be resurfaced for parking. This would raise the elevation of the site by 3 to 4 ft. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

Containment/Encapsulation. A slurry wall would be constructed to completely encircle the contaminated area. The proposed containment area is shown on Figure 5-6. The existing glacial till beneath the site would be relied upon to act as a bottom seal. An impervious cap of 3 ft of compacted clay covered by asphaltic concrete would be used to cover the top of the containment area.

Table 5-11

DETAILED COST ESTIMATE
NORTH DITCH
ALTERNATIVE 3
EXCAVATE-FIX-DISPOSE
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 1,520,000	0	$ 1,520,000
Health and safety requirements	840,000	0	840,000
General site preparation	100,000	0	100,000
Bypass North Ditch	4,720,000	0	4,720,000
Dewatering	1,660,000	$ 10,000	1,670,000
Water treatment plant and water disposal	170,000	10,000	180,000
Excavation and backfilling	560,000	0	560,000
Fixation	5,180,000	0	5,180,000
Transportation and disposal	2,860,000	0	2,860,000
Engineering, legal, and administration	2,990,000	10,000	3,000,000
Subtotal	20,600,000	30,000	20,630,000
Contingency	6,180,000	10,000	6,190,000
Total	$26,780,000	$40,000	$26,820,000

Table 5-12

DETAILED COST ESTIMATE
PARKING LOT
ALTERNATIVE 3
EXCAVATE-FIX-DISPOSE
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 2,040,000	0	$ 2,040,000
Health and safety requirements	1,120,000	0	1,120,000
General site preparation	330,000	0	330,000
Dewatering	380,000	$ 10,000	390,000
Water treatment plant and water disposal	10,000	10,000	20,000
Excavation and backfilling	1,280,000	0	1,280,000
Fixation	11,890,000	0	11,890,000
Transportation and disposal	6,560,000	0	6,560,000
Engineering, legal, and administration	4,020,000	10,000	4,030,000
Subtotal	27,630,000	30,000	27,660,000
Contingency	8,290,000	10,000	8,300,000
Total	$35,920,000	$40,000	$35,960,000

Temporary Storage Requirements. Parking Lot--Alternative 4 does not require temporary storage. It does, however, require long-term, onsite storage.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. In Parking Lot--Alternative 4, PCBs would be contained onsite. Groundwater monitoring wells would be required to determine whether PCBs were migrating from the contaminant area. Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external water levels so that any leakage is into the containment area. The area would be capped and returned to its original use as a parking lot, which would need to be properly maintained in order to continue to be an impermeable barrier to surface water.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. For Parking Lot--Alternative 4, no PCB-contaminated solids would require offsite disposal. USEPA waivers in accordance with 40 CFR 761 under TSCA would be required to leave the PCBs onsite. About 105,000 yd^3 of soil containing about 277,700 lb of PCBs would be contained in-place on the site at the eastern end of the Parking Lot area.

Major Equipment. Major construction equipment and utilities required for Parking Lot Area--Alternative 4 include:

- Backhoe
- Front end loader
- Dump trucks
- Slurry trench excavator
- Slurry mixing equipment
- Bulldozer
- Compactor
- Paving equipment
- Electrical lighting
- Water service for contractor's temporary facilities

Special Engineering Considerations. For Parking Lot--Alternative 4, special engineering considerations concerning containment and capping of the Parking Lot area include:

- Depth and construction techniques for the slurry wall to ensure its integrity

- The effects of PCBs on slurry walls

- Selection of cap materials and determination of correct placement methods

- Design of asphaltic concrete pavement for prolonged service as a membrane

Reliability. Parking Lot--Alternative 4 would not dispose of PCB-contaminated soil offsite but would contain and cap the Parking Lot area. There is no data on long-term reliability of this alternative. The shoreline of Lake Michigan is changing and may encroach upon the containment area. Groundwater fluctuations may cause drying and cracking of the slurry walls or the clay cap. Freezing and thawing action may also cause deterioration of the slurry walls and cap. The underlying glacial till may have cracks, fissures, or pockets of more permeable material through which PCBs could migrate. The containment area must be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment can be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry and cap wall below the frostline.

- Use of a flexible membrane for the cap could be considered for more freedom in site grading.

- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination in the Waukegan area and Lake Michigan. Parking Lot--Alternative 4 is considered reliable.

Costs. The Order-of-Magnitude cost estimate for Parking Lot--Alternative 4 is presented in Table 5-13. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The mobilization; health and safety requirements; engineering, legal, and administration; and contingency costs included in Table 5-13 for Parking Lot--Alternative 4 are the same as

Table 5-13

DETAILED COST ESTIMATE
PARKING LOT
ALTERNATIVE 4
CONTAIN-CAP
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 160,000	0	$ 160,000
Health and safety requirements	90,000	0	90,000
General site preparation	110,000	0	110,000
Slurry wall	750,000	0	750,000
Cap and regrade	500,000	0	500,000
Resurface parking lot	230,000	0	230,000
Monitoring (wells)	30,000	$240,000	270,000
Engineering, legal, and administration	320,000	40,000	360,000
Subtotal	2,190,000	280,000	2,470,000
Contingency	660,000	80,000	740,000
Total	$ 2,850,000	$360,000	$ 3,210,000

described for Slip No. 3--Alternative 2B. A description of the major elements included in the remaining Table 5-13 line items follows:

- General site preparation includes the costs to remove and replace pavement, reroute a 12-inch-diameter high-pressure gas line, and relocate a light pole.
- Slurry wall includes the costs to install a soil-bentonite slurry wall.
- Cap and regrade includes the costs to provide and install the filter fabric, drainage system, and clay cap.
- Resurface parking lot includes the costs to pave the containment area.
- Monitoring (wells) includes the costs for installing and monitoring groundwater monitoring wells.

Alternative 4A: Excavate-Contain-Cap (North Ditch Area Only)

A bypass would be constructed to divert surface water flow around the highly contaminated areas of the Crescent Ditch and Oval Lagoon (Figure 5-7). The bypass would fall directly into Lake Michigan. The North Ditch soils would be dewatered using well points and pumps. Well water would be routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the lake or to a sanitary sewer.

A slurry wall extending down into the underlying glacial till would then be constructed around the Crescent Ditch and Oval Lagoon to control movement of contaminated materials. The excavated PCB-contaminated soils from the North Ditch and about 3 ft of PCB-contaminated soil from the Crescent Ditch area would be placed and compacted in the Oval Lagoon area. Alternative 4A would control about 64 percent of all the PCBs now found in the North Ditch/Parking Lot area. The site would be capped with a 3-ft compacted clay layer to seal in the contaminated soils and reduce infiltration of surface water. The area would be resurfaced for parking. This would raise the elevation of the Oval Lagoon area by 20 to 25 ft. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

North Ditch Bypass. A gravity pipeline bypass would be constructed to divert surface water flow around the highly contaminated areas, the Crescent Ditch and Oval Lagoon. The location of the proposed bypass is shown on Figure 5-7. This bypass would collect drainage from the 36-inch-diameter storm drain (that flows north at the west edge of OMC's property), from OMC plant roof drains, and from regraded areas north and south of the Crescent Ditch. The bypass would discharge to Lake Michigan. It would be constructed south of the sheet piling just north of the east-west portion of the North Ditch. The Parking Lot area would be regraded to divert surface water flow to catch basins.

An area of PCB-contaminated soil approximately 15 ft deep by 25 ft wide from the North Ditch would be excavated and disposed of in the Oval Lagoon area. Before excavation, the existing sheet piling (along the north side of the North Ditch) would be fitted with extensions and driven an estimated 5 to 8 ft, penetrating into the confining clay layer. Additional sheet piling would be driven on the south side of the North Ditch. The area would then be dewatered. After excavation, the area would be backfilled and the gravity pipeline installed.

Containment/Encapsulation. A slurry wall would be constructed to completely encircle the contaminated area. The proposed containment area is shown on Figure 5-7. The existing glacial till beneath the site would be relied upon to act as a bottom seal. An impervious cap of 3 ft of compacted clay covered by asphaltic concrete would be used to cover the top of the containment area.

Temporary Storage Requirements. North Ditch--Alternative 4A does not require temporary storage. It does, however, require long-term, onsite storage.

Water Treatment. Groundwater removed from the areas to be excavated may need to be treated before it can be discharged back into the environment. The water treatment process would be the same used in Slip No. 3--Alternative 2B. The groundwater would be pumped directly to a 200-gpm package water treatment plant for treatment, and discharged to Lake Michigan or to a sanitary sewer. The treatment plant would be used for about 2 months.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. In North Ditch--Alternative 4A, PCBs would be contained onsite. Groundwater monitoring wells would be required to determine whether PCBs were migrating from the containment area. Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external water levels so that any leakage is into the containment area. The area would be capped. The cap would need to be properly maintained in order to continue to be an impermeable barrier to surface water.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. For North Ditch--Alternative 4A, no PCB-contaminated solids would require offsite disposal. USEPA waivers in accordance with 40 CFR 761 under TSCA would be required to leave the PCBs onsite. About 70,800 yd^3 of soil containing about 495,500 lb of PCBs would be contained in-place on the site.

Major Equipment. Major construction equipment and utilities required for North Ditch--Alternative 4A include:

- Pile driver
- Backhoe
- Front end loader
- Dump trucks
- Construction dewatering equipment
- Slurry trench excavator
- Slurry mixing equipment
- Bulldozer
- Compactor
- Paving equipment
- Electrical lighting
- Water service for contractor's temporary facilities

Special Engineering Considerations. For North Ditch--Alternative 4A, the following special engineering considerations are presented.

Engineering considerations concerning construction dewatering (groundwater) include:

- Rate and duration of well point pumping before satisfactory moisture content in soils is obtained

Engineering considerations concerning excavation include:

- Possible contamination behind sheet piles adjacent to the North Ditch

Engineering considerations concerning the water treatment process include:

- Determining the cost-effectiveness of replacing activated carbon with Klensorb for soluble PCB removal if the activated carbon should become blinded by the oily nature of PCBs

- Water quality requirements for discharging to the lake or to a sanitary sewer

Engineering considerations concerning containment and capping of the North Ditch area include:

- Depth and construction techniques for the slurry wall to ensure its integrity

- The effects of PCBs on slurry walls

- Selection of cap materials and determination of correct placement methods

- Design of asphaltic concrete pavement for prolonged service as a membrane

Reliability. North Ditch--Alternative 4A would not dispose of PCB-contaminated soil offsite but would contain and cap the Crescent Ditch and Oval Lagoon area. There is no data on long-term reliability of this alternative. The shoreline of Lake Michigan is changing and may encroach upon the containment area. Groundwater fluctuations may cause drying and cracking of the slurry walls or the clay cap. Freezing and thawing action may also cause deterioration of the slurry walls and cap. The underlying glacial till may have cracks, fissures, or pockets of more permeable material through which PCBs could migrate. The containment area must be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment can be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry and cap wall below the frostline.

- Use of a flexible membrane for the cap could be considered for more freedom in site grading.

- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination of the Waukegan area and Lake Michigan. North Ditch--Alternative 4A is considered reliable.

Costs. The Order-of-Magnitude cost estimate for North Ditch--Alternative 4A is presented in Table 5-14. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The mobilization; health and safety requirements; engineering, legal, and administration; and contingency costs included in Table 5-14 for North Ditch--Alternative 4A are the same as described for Slip No. 3--Alternative 2B. A description of the major elements included in the remaining Table 5-14 line items follows:

- General site preparation includes the costs to remove and relocate the chain link fence and railroad tracks, remove and replace pavement, reroute the 10-inch-diameter sanitary sewer, relocate propane tanks, underpin the elevated water tank, and install new manholes for rerouting the sewer.

- Bypass includes the costs to install the pipeline around the Crescent Ditch and Oval Lagoon areas and through the east-west portion of the North Ditch.

- Slurry wall includes the costs to install a soil-bentonite slurry wall.

- Cap and grade includes the costs to provide and install the filter fabric, drainage system, and clay cap; to excavate material from the Crescent Ditch area; and to place excavated material in the Oval Lagoon area.

- Resurface includes the costs to pave the containment area.

- Monitoring (wells) includes the costs for installing and monitoring the groundwater monitoring wells.

Alternative 4B: Excavate-Contain Part of E-W Portion of the North Ditch-Cap (North Ditch Area Only)

A bypass would be constructed to divert surface water flow around the highly contaminated areas of the Crescent Ditch and Oval Lagoon (Figure 5-7). The bypass would fall directly into Lake Michigan. The North Ditch soils would be dewatered using well points and pumps. Well water would be routed to an onsite water treatment plant for suspended solids and PCB removal (to 1 ppb PCBs), then discharged to the lake or to a sanitary sewer.

Table 5-14

DETAILED COST ESTIMATE
NORTH DITCH
ALTERNATIVE 4A
EXCAVATE-CONTAIN-CAP
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 480,000	0	$ 480,000
Health and safety requirements	260,000	0	260,000
General site preparation	110,000	0	110,000
Bypass	3,510,000	0	3,510,000
Slurry Wall	610,000	0	610,000
Cap and Grade	410,000	0	410,000
Resurface	100,000	0	100,000
Monitoring (wells)	20,000	$240,000	260,000
Engineering, legal, and administration	930,000	40,000	970,000
Subtotal	$ 6,430,000	280,000	6,710,000
Contingency	1,930,000	80,000	2,010,000
Total	$ 8,360,000	$360,000	$ 8,720,000

A slurry wall extending down into the underlying glacial till would then be constructed around the Crescent Ditch and Oval Lagoon to control movement of contaminated materials. The excavated PCB-contaminated soils from the North Ditch and about 3 ft of PCB-contaminated soil from the Crescent Ditch area would be placed and compacted in the Oval Lagoon area. This alternative would not address approximately 19,500 yd^3 of soil containing 3,400 lb of PCBs with concentrations between 50 and 5,000 ppm in the east-west portion of the North Ditch. Alternative 4B, however, would control about 64 percent of all the PCBs now found in the North Ditch/Parking Lot area. The site would be capped with a 3-ft compacted clay layer to seal in the contaminated soils and reduce infiltration of surface water. The area would be resurfaced for parking. This would raise the elevation of the Oval Lagoon area by about 10 ft. Groundwater monitoring wells would be installed around the site for detection of potential PCB migration.

North Ditch Bypass. A gravity pipeline bypass would be constructed to divert surface water flow around the highly contaminated areas, the Crescent Ditch and Oval Lagoon. The location of the proposed bypass is shown on Figure 5-7. This bypass would collect drainage from the 36-inch-diameter storm drain (that flows north at the west edge of OMC's property), from OMC plant roof drains, and from regraded areas north and south of the Crescent Ditch. The bypass would discharge to Lake Michigan. It would be constructed south of the sheet piling just north of the east-west portion of the North Ditch. The Parking Lot area would be regraded to divert surface water flow to catch basins.

An area of PCB-contaminated soil approximately 10 ft deep by 7 ft wide would be excavated from the North Ditch and disposed of in the Oval Lagoon area. The area would be dewatered. After excavation, the area would be backfilled and the gravity pipeline installed.

Containment/Encapsulation. A slurry wall would be constructed to completely encircle the contaminated area. The proposed containment area is shown on Figure 5-7. The existing glacial till beneath the site would be relied upon to act as a bottom seal. An impervious cap of 3 ft of compacted clay covered by asphaltic concrete would be used to cover the top of the containment area and the east-west portion of the North Ditch (bypass area).

Temporary Storage Requirements. North Ditch--Alternative 4B does not require temporary storage. It does, however, require long-term, onsite storage.

Water Treatment. Groundwater removed from the areas to be excavated may need to be treated before it can be discharged back into the environment. The water treatment process would be the same used in Slip No. 3--Alternative 2B. The groundwater would be pumped directly to a 200-gpm package water treatment plant for treatment, and discharged to Lake Michigan or to a sanitary sewer. The treatment plant would be used for about 2 months.

Operation, Maintenance, and Monitoring Requirements of the Completed Remedy. In North Ditch--Alternative 4B, PCBs would be contained onsite. Groundwater monitoring wells would be required to determine whether PCBs were migrating from the containment area. Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external water levels so that any leakage is into the containment area. The area would be capped. The cap would need to be properly maintained in order to continue to be an impermeable barrier to surface water.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. For North Ditch--Alternative 4B, no PCB-contaminated solids would require offsite disposal. USEPA waivers in accordance with 40 CFR 761 under TSCA would be required to leave the PCBs onsite. About 51,400 yd^3 of soil containing about 492,100 lb of PCBs would be contained in-place on the site.

Major Equipment. Major construction equipment and utilities required for North Ditch--Alternative 4B include:

- Pile driver
- Backhoe
- Front end loader
- Dump trucks
- Construction dewatering equipment
- Slurry trench excavator
- Slurry mixing equipment
- Bulldozer
- Compactor
- Paving equipment
- Electrical lighting
- Water service for contractor's temporary facilities

Special Engineering Considerations. For North Ditch--Alternative 4B, the following special engineering considerations are presented.

Engineering considerations concerning construction dewatering (groundwater) include:

- Rate and duration of well point pumping before satisfactory moisture content in soils is obtained

Engineering considerations concerning excavation include:

- Possible contamination behind sheet piles adjacent to the North Ditch

Engineering considerations concerning the water treatment process include:

- Determining the cost-effectiveness of replacing activated carbon with Klensorb for soluble PCB removal if the activated carbon should become blinded by the oily nature of PCBs

- Water quality requirements for discharging to the lake or to a sanitary sewer

Engineering considerations concerning containment and capping of the North Ditch area include:

- Depth and construction techniques for the slurry wall to ensure its integrity

- The effects of PCBs on slurry walls

- Selection of cap materials and determination of correct placement methods

- Design of asphaltic concrete pavement for prolonged service as a membrane

Reliability. North Ditch--Alternative 4B would not dispose of PCB-contaminated soil offsite but would contain and cap the Crescent Ditch and Oval Lagoon area. There is no data on long-term reliability of this alternative. The shoreline of Lake Michigan is changing and may encroach upon the containment area. Groundwater fluctuations may cause drying and cracking of the slurry walls or the clay cap. Freezing and thawing action may also cause deterioration of the slurry walls and cap. The underlying glacial till may have cracks, fissures, or pockets of more permeable material through which PCBs could migrate. The containment area must be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment can be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry and cap wall below the frostline.

- Use of a flexible membrane for the cap could be considered for more freedom in site grading.

- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination of the Waukegan area and Lake Michigan. North Ditch--Alternative 4B is considered reliable.

Costs. The Order-of-Magnitude cost estimate for North Ditch--Alternative 4B is presented in Table 5-15. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The mobilization; health and safety requirements; engineering, legal, and administration; and contingency costs included in Table 5-15 for North Ditch--Alternative 4B are the same as described for Slip No. 3--Alternative 2B. A description of the major elements included in the remaining Table 5-15 line items follows:

- General site preparation includes the costs to remove and relocate the chain link fence and railroad tracks, remove and replace pavement, reroute the 10-inch-diameter sanitary sewer, relocate propane tanks, underpin the elevated water tank, and install new manholes for rerouting the sewer.

- Bypass includes the costs to install the pipeline around the Crescent Ditch and Oval Lagoon areas and through the east-west portion of the North Ditch.

- Slurry wall includes the costs to install a soil-bentonite slurry wall.

- Cap and grade includes the costs to provide and install the filter fabric, drainage system, and clay cap; to excavate material from the Crescent Ditch area; and to place excavated material in the Oval Lagoon area.

Table 5-15

DETAILED COST ESTIMATE
NORTH DITCH
ALTERNATIVE 4B
EXCAVATE-CONTAIN-CAP
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 220,000	0	$ 220,000
Health and safety requirements	120,000	0	120,000
General site preparation	110,000	0	110,000
Bypass	1,050,000	0	1,050,000
Slurry Wall	610,000	0	610,000
Cap and Grade	300,000	0	300,000
Resurface	100,000	0	100,000
Monitoring (wells)	20,000	$240,000	260,000
Engineering, legal, and administration	430,000	40,000	470,000
Subtotal	$ 2,960,000	280,000	3,240,000
Contingency	890,000	80,000	970,000
Total	$ 3,850,000	$360,000	$ 4,210,000

- Resurface includes the costs to pave the containment area.

- Monitoring (wells) includes the costs for installing and monitoring the groundwater monitoring wells.

Subalternative I: Select Excavation

This subalternative would be used only in conjunction with Alternatives 4A or 4B. "Hot spots" would be removed from the Crescent Ditch/Oval Lagoon area and disposed of offsite. "Hot spots" consist of 5,500 yd^3 of soils with PCB concentrations in excess of 10,000 ppm. Subalternative I would remove and dispose of offsite 57 percent of all the PCBs now found in the North Ditch/Parking Lot area (440,500 lb of PCBs). These soils would be excavated and then loaded into trucks for transportation to an approved disposal site.

Offsite Disposal Needs, Permit Requirements, and Transportation Plans. These items would be the same as for Slip No. 3--Alternative 2B, except that about 5,500 yd^3 of PCB-contaminated solids would require disposal. For Alternative 4A in conjunction with Subalternative I, about 65,300 yd^3 of soil containing 53,000 lb of PCBs would be contained in-place in the containment area. For Alternative 4B, about 45,900 yd^3 of sediment containing 51,600 lb of PCBs would be contained in-place in the containment area. A permit to operate construction equipment under the existing power line would be required.

Special Engineering Considerations. The following special engineering considerations are presented.

Engineering considerations concerning disposal of the PCB-contaminated soils include:

- Ensuring that the soils have a nonflowable consistency

- Ensuring that moisture or solids do not escape during transport and disposal of the soils

- Controlling volatilization

Reliability. North Ditch--Subalternative I would remove and dispose of PCB-contaminated soils with concentrations greater than 10,000 ppm from the Crescent/Ditch Oval Lagoon area. Subalternative I includes excavation and then disposal in a licensed chemical waste landfill. This subalternative would be effective in abating further PCB contamination of the Waukegan area and Lake Michigan. Subalternative I is considered reliable.

Costs. The Order-of-Magnitude cost estimate for North Ditch--Subalternative I is presented in Table 5-16. This cost estimate was developed as described for Slip No. 3--Alternative 2B.

The mobilization; health and safety requirements; engineering, legal, and administration; and contingency costs included in Table 5-16 for North Ditch--Subalternative I are the same as described for Slip No. 3--Alternative 2B. The description of the major elements included in the remaining Table 5-16 line items follows:

- Excavation includes the costs to excavate the "hot spots" in Crescent Ditch and Oval Lagoon.

- Transportation and disposal includes the costs to haul the contaminated material to an approved hazardous waste landfill.

Table 5-16

DETAILED COST ESTIMATE
NORTH DITCH
SUBALTERNATIVE I
SELECT EXCAVATION
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Description	Capital Costs	Present Worth of O&M Costs	Present Worth
Mobilization	$ 40,000	0	$ 40,000
Health and safety requirements	20,000	0	20,000
Excavation	150,000	0	150,000
Transportation and disposal	280,000	0	280,000
Engineering, legal, and administration	80,000	0	80,000
Subtotal	570,000	0	570,000
Contingency	170,000	0	170,000
Total	$ 740,000	0	$ 740,000

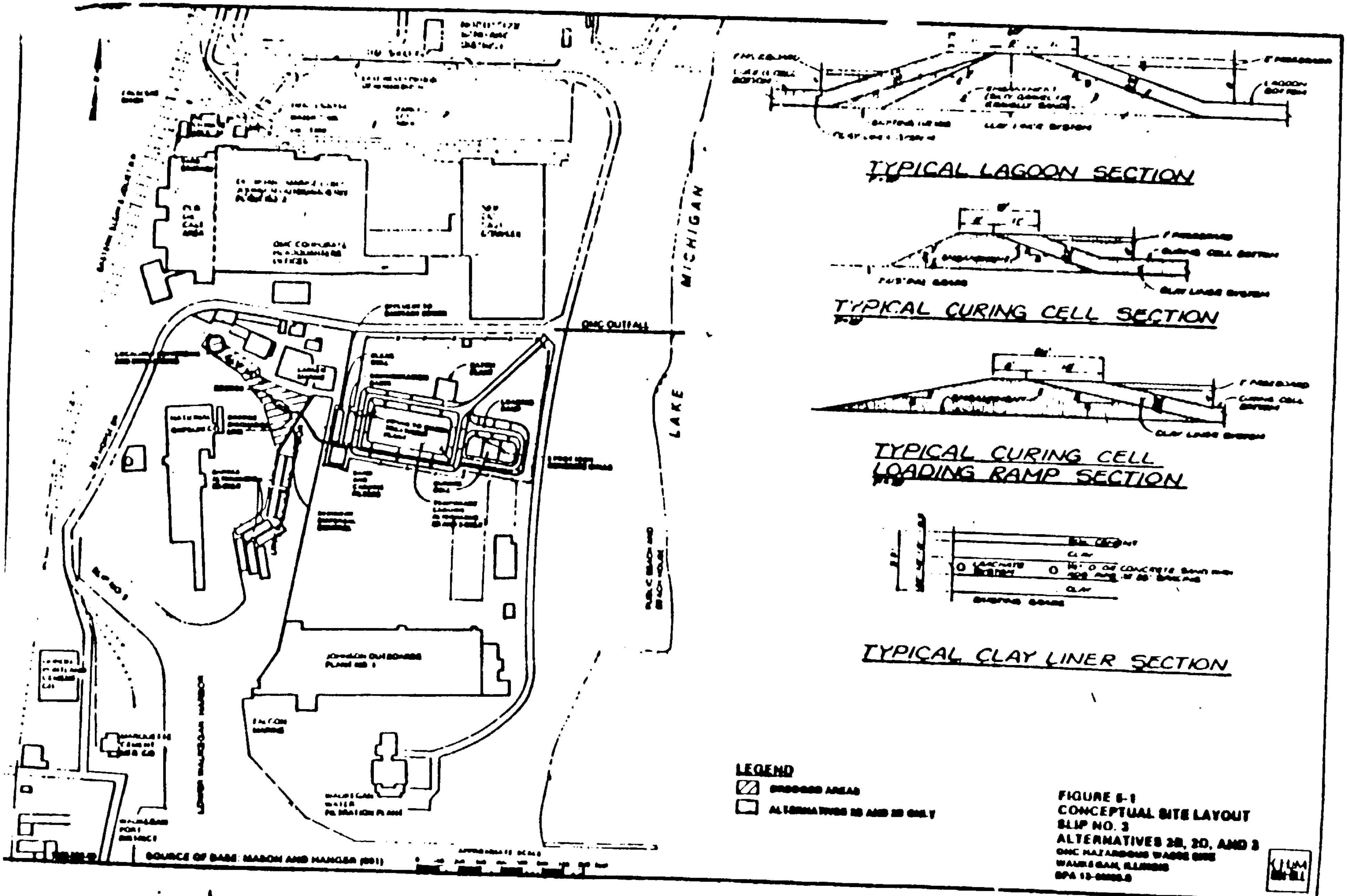


FIGURE 6-1
CONCEPTUAL SITE LAYOUT
SLIP NO. 3
ALTERNATIVES 2B, 2D, AND 3
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

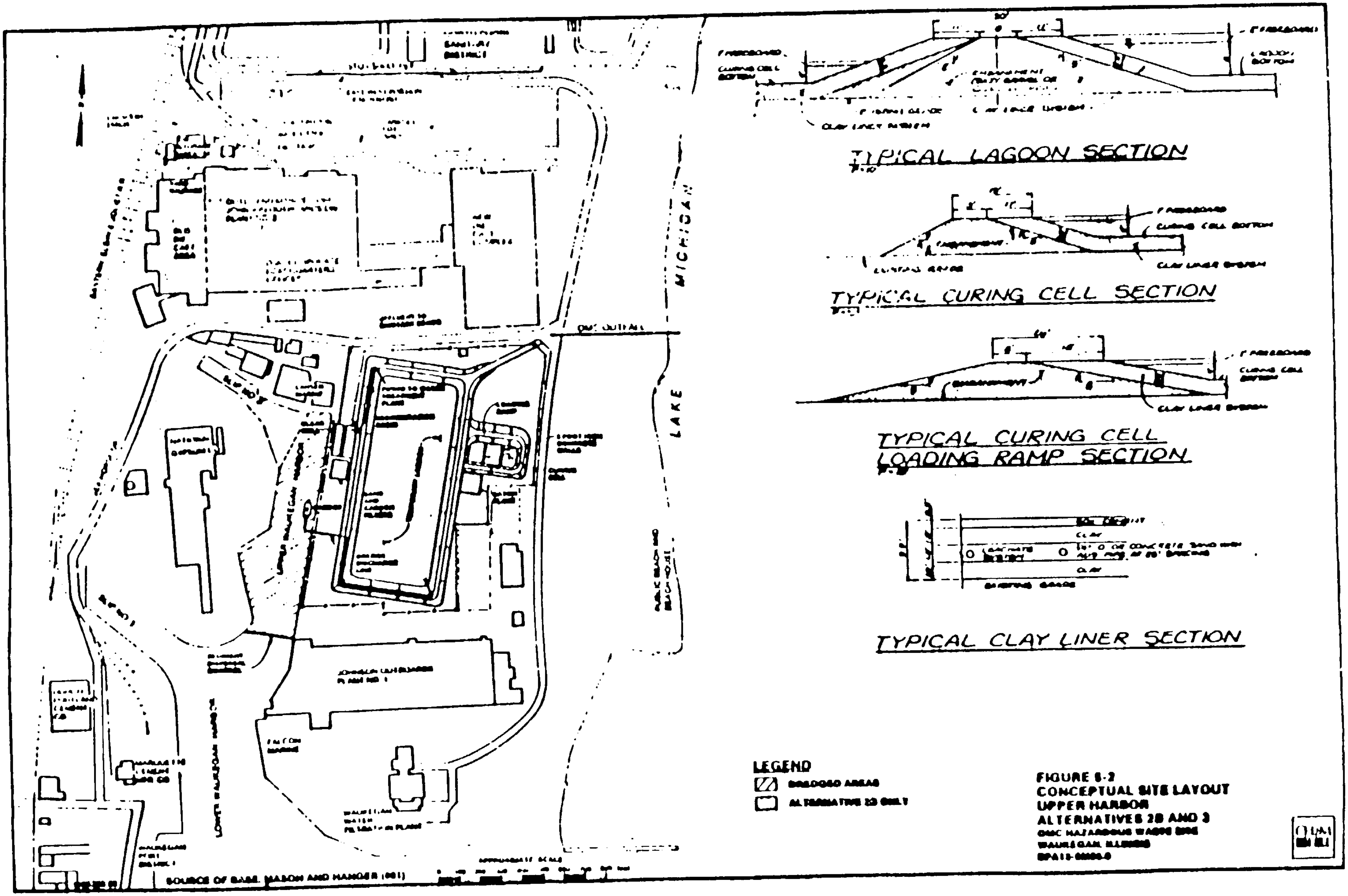


FIGURE 5-2
CONCEPTUAL SITE LAYOUT
UPPER HARBOR
ALTERNATIVES 2B AND 3

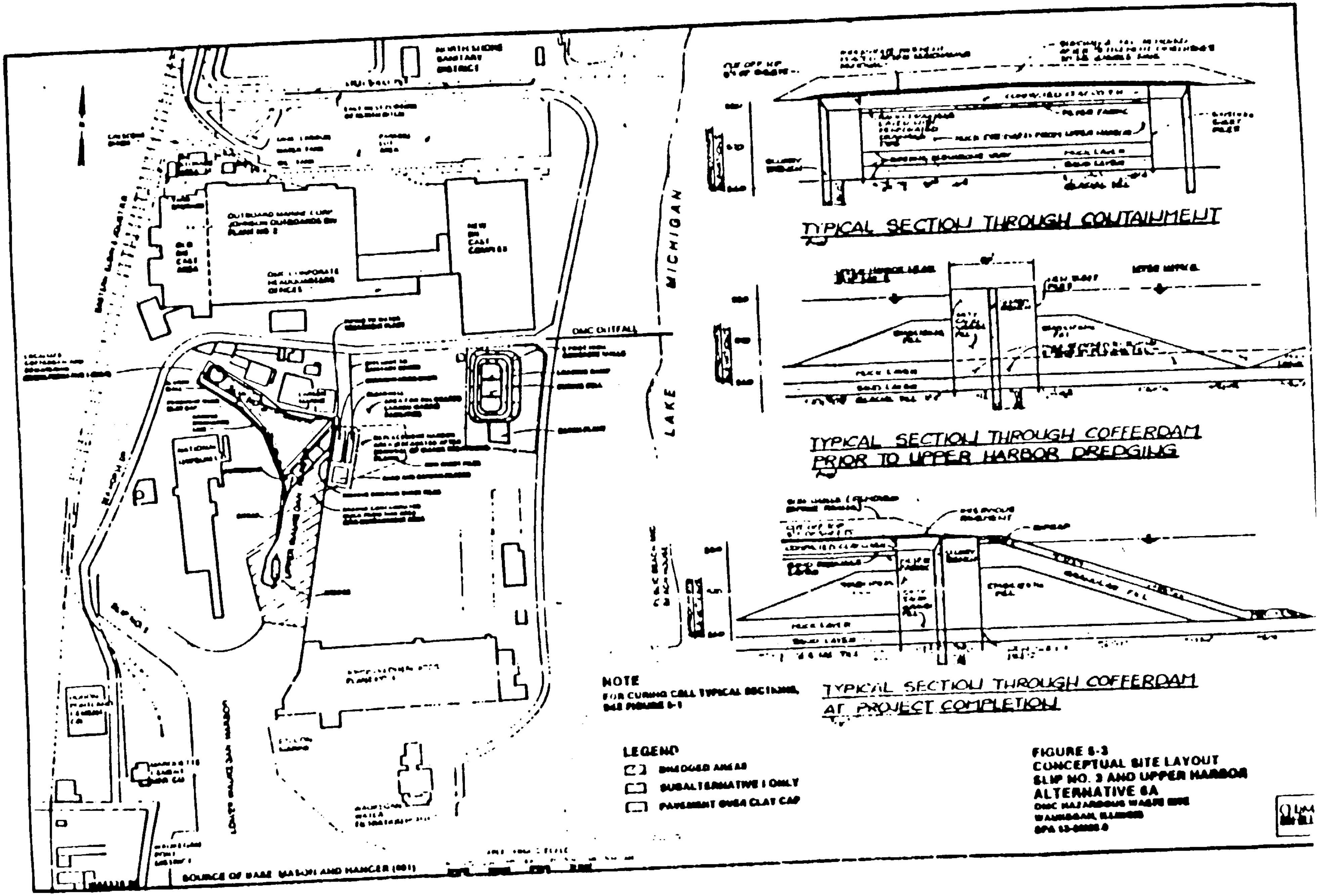
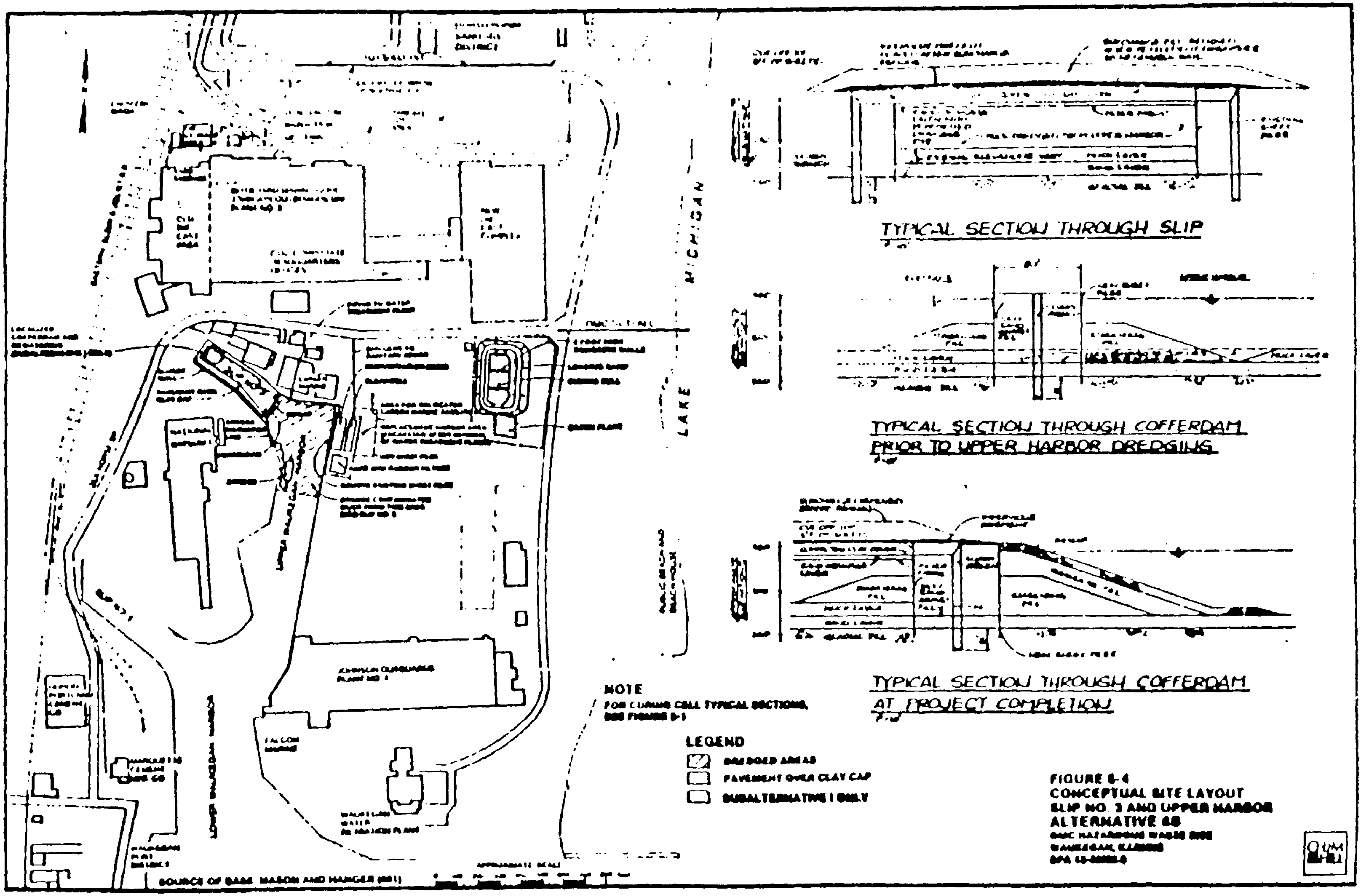


FIGURE 5-3
CONCEPTUAL SITE LAYOUT
SLIP NO. 3 AND UPPER HARBOR
ALTERNATIVE 6A
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS


TYPICAL SECTION THROUGH SLIP
TYPICAL SECTION THROUGH COFFERDAM PRIOR TO UPPER HARBOR DREDGING
TYPICAL SECTION THROUGH COFFERDAM AT PROJECT COMPLETION
LAKE MICHIGAN
JOHNSON OUTBOARDS PLANT NO. 1
FALCON MARINE
UPPER WAUKEGAN HARBOR
LOWER WAUKEGAN HARBOR
NOTE
LEGEND
DREDGED AREAS
PAVEMENT OVER CLAY CAP
SUBALTERNATIVE I ONLY
CONCEPTUAL SITE LAYOUT
SLIP NO. 3 AND UPPER HARBOR
SOURCE OF BASE: MASON AND HANGER

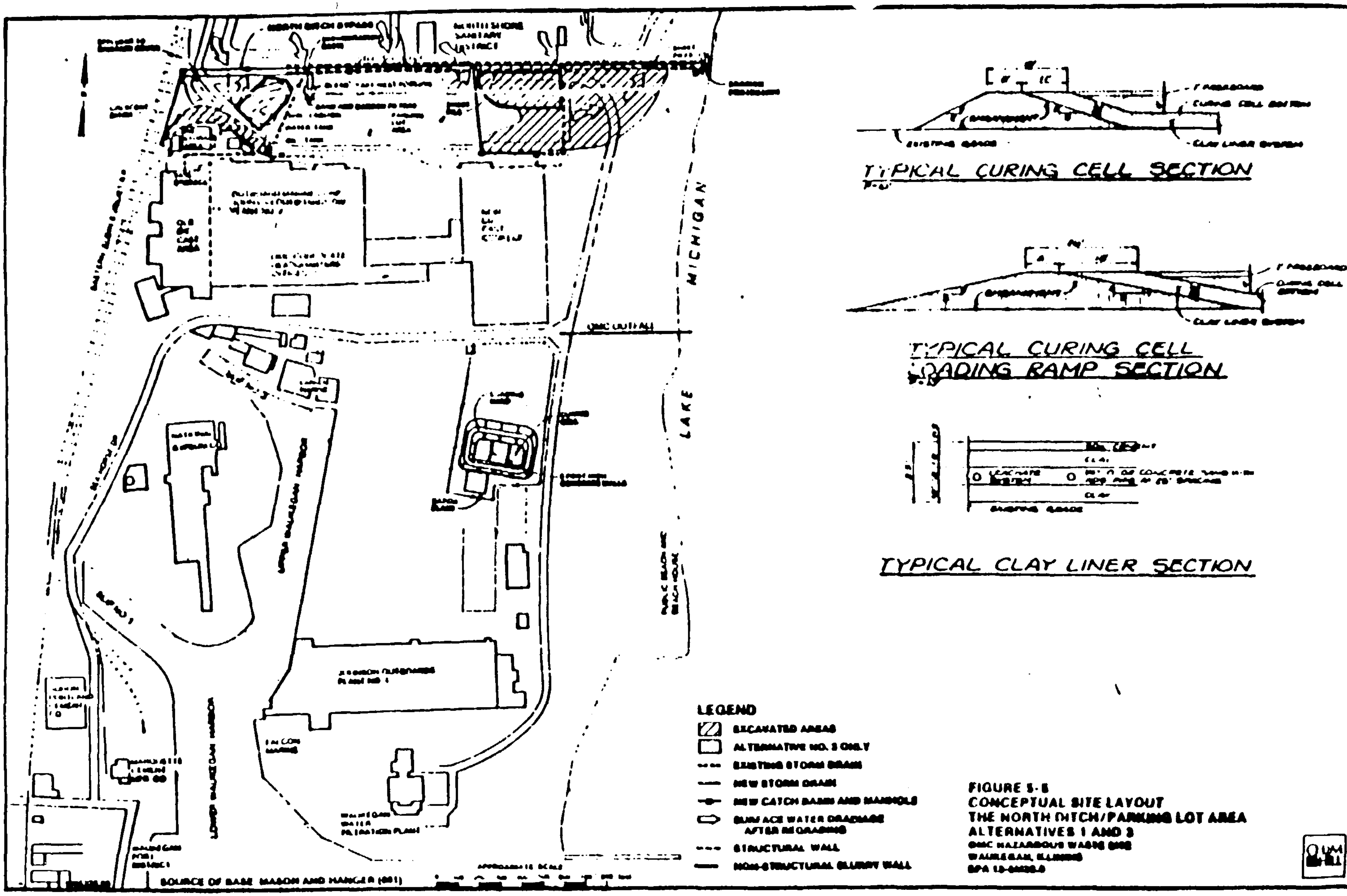


FIGURE 5-5
CONCEPTUAL SITE LAYOUT
THE NORTH DITCH/PARKING LOT AREA
ALTERNATIVES 1 AND 3
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

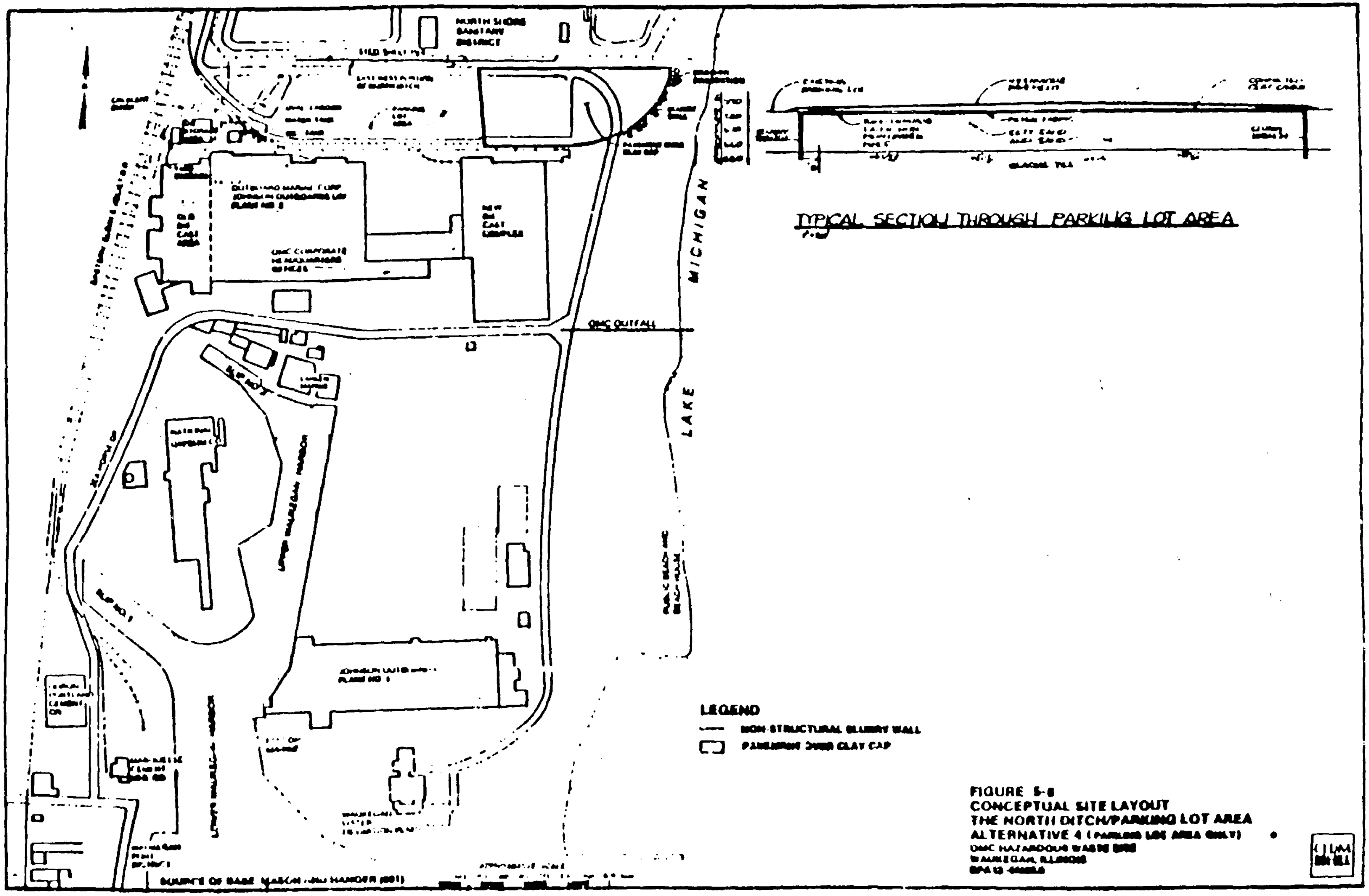


FIGURE 5-8
CONCEPTUAL SITE LAYOUT
THE NORTH DITCH/PARKING LOT AREA
ALTERNATIVE 4 (PARKING LOT AREA ONLY)
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

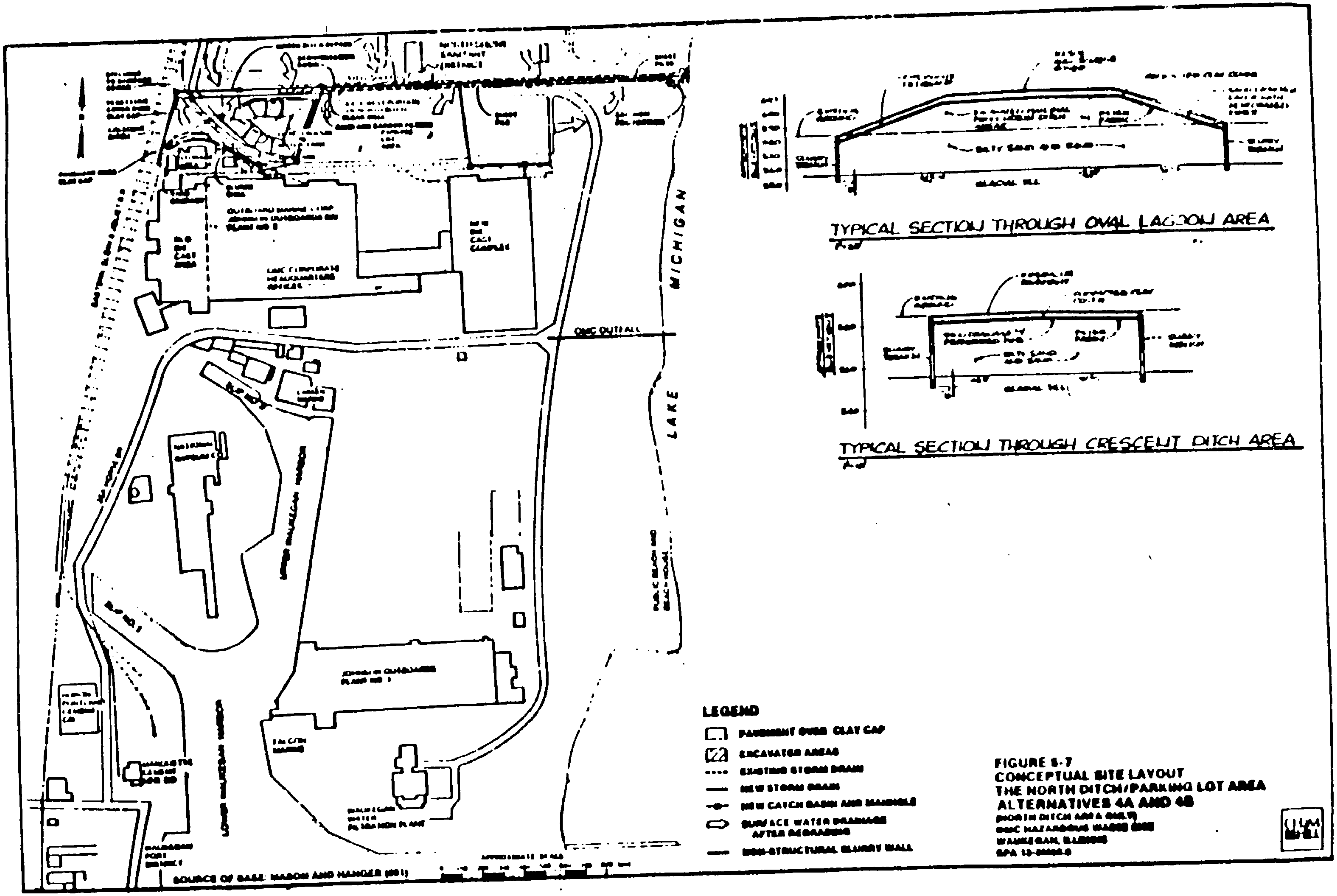


FIGURE 5-7
CONCEPTUAL SITE LAYOUT
THE NORTH DITCH/PARKING LOT AREA
ALTERNATIVES 4A AND 4B
(NORTH DITCH AREA ONLY)
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

Section 6
DETAILED EVALUATION--ENVIRONMENTAL ASPECTS

This section discusses the potential environmental impacts of the alternatives retained in Section 4. The engineering and cost aspects of these alternatives are discussed in Section 5.

This section is divided into three main parts. The first part is a description of the affected environment of the Waukegan Harbor vicinity. This description is a synopsis of an unpublished environmental assessment prepared by WAPORA, Inc., under contract to USEPA Region V (048).

The second part discusses the impacts of no action. It describes contamination levels that would remain for each of the four subareas under consideration: Slip No. 3, the Upper Harbor, the North Ditch area (North Ditch, Crescent Ditch, and Oval Lagoon), and the Parking Lot area. It then summarizes the impacts of PCB contamination on fish, animals, public health and safety, and socioeconomics.

The third part is an evaluation of each remedial action alternative. It includes impacts and mitigation measures; the duration of cleanup activities; an evaluation of the reliability of cleanup techniques; and permit requirements.

PART 1: AFFECTED ENVIRONMENT

The affected environment consists of the natural and manmade resources of the Waukegan Harbor area. For the purposes of this discussion, Waukegan Harbor is broadly defined as the area encompassing both Waukegan Harbor and the nearshore zone of Lake Michigan along northern Illinois. The following discussion is a synopsis of an unpublished environmental assessment prepared by WAPORA, Inc., under contract to USEPA Region V (048).

CLIMATE

The climate of Waukegan is predominantly continental and is similar to that of Chicago. However, the presence of the Great Lakes, especially Lake Michigan, has a moderating effect on climatic conditions. In 1980, the average summer temperature was 72.2°F and the average winter temperature was 24.3°F.

Although precipitation in the project area is produced primarily by warm moist air masses that pass over the Gulf of Mexico, Lake Michigan often is the source of moisture for heavy winter snowfalls. Thunderstorms which occur in the summer usually are heavy and variable.

The predominant winds are from the west-northwest and are stronger along the lakefront. Wind speeds in Chicago in 1980 averaged 9.9 mph. Average wind speeds were higher in the winter months (10.7 mph) than in the summer months (8.0 mph).

NOISE

Several industries are located in the harbor area, and noise generated by industrial operations can be expected near and around the harbor. The majority of this noise can be attributed to transportation-related activities (truck hauling, barge traffic, and railroads). The strict enforcement of the 5-knot speed limit in the harbor is effective in reducing noise levels attributable to barge traffic. It also minimizes noise generated by recreational boats. Some railroad noise can also be expected from the two lines that run along the western border of the harbor.

TOPOGRAPHY

Lake County is located in the Wheaton Morainal part of the Great Lakes section of the Central Lowland province. A narrow strip of land approximately 2.0 to 3.0 miles wide along the eastern edge of the county, in which much of the City of Waukegan is located, drains into Lake Michigan. The majority of the remaining land area drains into the Des Plaines River or into the Fox River in the western part of the county.

The elevations in the project area are less than 600 ft National Geodetic Vertical Datum (NGVD), and the entire harbor area east of Pershing Road is slightly less than 590 ft NGVD. The area immediately surrounding Waukegan Harbor is relatively flat and has a slight slope to the east toward Lake Michigan.

The coastal water and harbor water are designated as within Zone A2 of the flood hazard boundary map prepared for the City of Waukegan in 1976 by the Federal Insurance Administration of the U.S. Department of Housing and Urban Development. This designation indicates that there is a 2-ft elevation difference between the land areas that would be affected by the 10-year flood and the 100-year flood. The highest elevation reached during the 10-year flood is 582 ft NGVD, and the highest elevation reached during the 100-year flood is 584 ft NGVD. The land immediately surrounding Waukegan Harbor is within Zone C, a designation which indicates an area of minimal flooding (above the 100-year flood).

GEOLOGY

An examination of the geology of the shoreline in the vicinity of the project area suggests that accretion rather than erosion is occurring and that erosion of the shore and/or the engineered facilities may not be a problem during the project period. The surficial sandy soils are underlain at shallow depths by clayey strata of great lateral extent.

SOILS

The entire Waukegan Harbor area is made land. Thus, the substrate material is probably a mixture of spoil, building rubble, and beach sand. Prior to filling, the area was a combination of wet marsh soils and beach sands. Present soil characteristics are a function of manmade deposits and naturally deposited beach sands.

GROUNDWATER

The sand and gravel associated with glacial drift deposits in the vicinity of Waukegan and the Silurian dolomite on which they are located comprise the shallow groundwater system. Rainfall provides local recharge to this system and indirectly to deeper aquifers. In the Waukegan area, the next important aquifer below the dolomite is the St. Peter Sandstone, the top of which is approximately 780 ft beneath the surface. In this part of Lake County, large quantities of good quality water occur mainly at considerable depths.

Sand and gravel deposits form the main aquifers in the shallow glacial drift. The distribution of these bodies is erratic and discontinuous, reflecting the nature of the glacial and periglacial water bodies in which they were deposited. The glacial till deposits slope gently toward Lake Michigan. A typical cross section of the beach ridge complex that makes up the Waukegan shore would show shallow sand and/or gravel aquifers approximately 10 to 15 ft thick at depths to 75 or 100 ft. In the Waukegan area, these aquifers are not exceptionally productive. The water of Lake Michigan does not recharge the subsurface aquifers.

An investigation conducted for USEPA in 1979 and 1980 indicated that the contamination in the North Ditch and Parking Lot area is contained in a water table aquifer composed of sand and gravel. The water table aquifer is underlain by an aquitard and is hydraulically connected with the water of Lake Michigan. Water movement in the aquifer is influenced by water levels in Lake Michigan and by stormwater in the North Ditch. The North Ditch drainage system is connected to the lake. When the water level in the ditch is relatively low, groundwater moves toward the ditch in both a horizontal and vertical (upward) direction. When water in the ditch is relatively high, recharge to the aquifer occurs at shallow soil depths. At greater depths, water passes under the ditch with a slow lakeward component of movement. Following any rapid rises of the water level in the ditch associated with stormwater, the velocity of the lakeward groundwater flow increases.

In the general vicinity of Waukegan, water from the Silurian dolomite is reported to contain hydrogen sulfide in quantities sufficient to impair its quality for domestic use. The City of Waukegan obtains its water supply from Lake Michigan; thus, little demand is placed on the shallow groundwater of the area.

SURFACE WATER QUALITY

The water quality data of greatest interest are turbidity, suspended solids, chemical oxygen demand (COD), biochemical oxygen demand (BOD), and oil and grease because they reflect spatial and temporal variations in the amount of suspended organic material in the surface water. It is generally acknowledged that PCBs have a high affinity for organic materials and absorb to them preferentially. Therefore, when the parameters of interest are found in high concentrations, it can be inferred that there also are increased amounts of PCBs associated with suspended autochthonous material.

Seasonal variations in turbidity are evident from sampling data obtained from studies on Lake Michigan by various agencies. Sampling data for five USGS sampling stations located on the Illinois shore of Lake Michigan, collected during the months of April to October from 1968 to 1976, indicate that levels are high in the spring, decrease during the summer months, and increase gradually in the autumn. Although the data are variable among the five stations, the levels were consistently lowest at the two Waukegan Beach stations. Annual sampling done at three stations near Waukegan Harbor by Industrial Bio-test Laboratories, Inc., resulted in a similar seasonal pattern. Limnetics, Inc., sampled turbidity near Waukegan Harbor on March 14, 1974, and on July 24-25, 1974. Turbidity levels ranged from 2 to 5 Jackson Turbidity Units (JTU) in July and from 57 to 59 JTU in March. The higher springtime levels are thought to be due primarily to the effects of spring runoff and increased storm-related movement of water and sediment. Spatial variations of turbidity levels near Waukegan are also evident from the data.

In 1971, seasonal variations of total suspended solids (TSS) were evident at a sampling station located at the Commonwealth Edison coal-fired generating station north of Waukegan Harbor. Maximum levels measured were 120 mg/l during the spring and autumn months. Levels of TSS were highest during the spring and the autumn. The generating station intake is located in a harbor immediately north of Waukegan Harbor; thus, it is likely that variations in TSS found there are representative of the Waukegan Harbor area.

Dissolved oxygen (DO) concentrations usually are near saturation at all depths of Lake Michigan throughout the year, except for harbors and certain inshore areas near Chicago. In the Waukegan area, as elsewhere, minimum DO concentrations were recorded during the summer and maximum concentrations occurred in the winter. BOD and COD measurements are made to determine the potential effect of oxygen-demanding material on the aquatic environment. Although BOD_5 often varies seasonally, this trend is not reflected in the limited data available for the Waukegan area. The results of samples taken at five stations along the western shore of Lake Michigan during the months of April through October in 1978 and 1979 did not indicate a seasonal trend in COD. Monthly BOD_5 and COD values recorded over a 1-year period did not indicate a seasonal pattern at three inshore stations near Waukegan.

Recreational and industrial activities are major sources of oil and grease in surface waters. Levels of these substances often are higher in harbor areas due to commercial or recreational navigation and the relatively restricted flow patterns. Sampling for oil and grease was done at several stations near the US Steel plant south of Waukegan. The levels measured generally were less than 1.0 mg/l in March and July for the inshore stations. Offshore, the level at one station reached a high of 9.0 mg/l. Two offshore stations located between Waukegan and the US Steel plant had concentrations of 9.0 mg/l and 2.5 mg/l, respectively.

The extensive recreational and commercial boating activities in Waukegan Harbor are likely to result in periodic increases in turbidity and other related pollutants wherever depths average less than about 10 feet. Other pollutant sources to Lake Michigan include permitted discharges for local industry and for the Waukegan sewage treatment plant. Heavy industrial use of the lands surrounding Waukegan Harbor more than likely results in seasonal high surface runoff-borne loads of heavy metals and dust. The cumulative result of the surrounding industrial setting, recreational boating activity, commercial shipping, and lack of flow-through water movement is a highly turbid harbor. The fact that periodic maintenance dredging has been conducted in the harbor indicates considerable sediment deposition from numerous sources.

TERRESTRIAL BIOTA

The Waukegan Harbor area lies within the Lake Michigan Dunes Section of the Northeastern Morainal Division of Illinois. This is the most recently glaciated area of the state, and many rare species of plants are present in Illinois Beach State Park, approximately 1.5 miles north of Waukegan harbor. The natural communities present in the harbor area include those characteristic of and limited to the shore of Lake Michigan (beach and foredune communities) and those characteristic of disturbed areas (successional communities and developed land).

Vegetation

The area to the east of the project site is a public beach, the major part of which is unvegetated, lake-deposited sand. The predominant plants in the beach area are sea rocket, winged pigweed, and cocklebur. Sand-binding plants such as marram grass, common bugseed, and Canada wild rye help to stabilize the dunes and provide substrates on which various insects and spiders live. The more protected foredune areas behind the strand contain species of plants such as beach wormwood, little bluestem grass, silverweed, bearberry, and trailing juniper. Cottonwoods, dogwoods, willows, and other shrubs and trees are present at the western edge of the beach. Successional communities have developed in the disturbed area between the cottonwood-willow band and Seashore Road. Large chunks of concrete and rocks have been piled at this location. Rushes, blue vervain, wild bergamot, and other weedy species are present in most spots around and to the west of these slabs.

Honey locust trees have become established (possibly planted) in the area immediately north of the concession stand at the north end of the beach parking lot. Rushes also are present in wet spots in this area. Squirrel-tail grass and other weeds are common in disturbed sites around the picnic shelter and the parking lot.

Silver maples, oaks, and conifers have been planted adjacent to the North Beach Park parking lot. The southwestern part of the beach has a grass cover and contains weeping willows, cottonwoods, and Scotch pines. Beach Park, located at the west edge of the inlet, also has a grass understory and contains cottonwoods and crabapples.

The areas on the western edge of the project site in the vicinity of the railroad track contain weedy communities typical of disturbed ground. There are thickets of willows, cottonwoods, and wild grape in the moister sites west of the tracks. Prairie cord grass, butterfly weed, black-eyed susans, and other species typical of prairie communities are present in this area.

A marsh community is located to the north of the project site, adjacent to the cooling ponds on the property owned by Commonwealth Edison. Some of the species of wildlife that are present in the Waukegan Harbor area undoubtedly feed or rest in this area also.

The center of the OMC vacant property contains spoil piles covered with shrubby and weedy successional vegetation similar to that described previously. Various species of coniferous and deciduous trees have been planted on the property for landscaping purposes.

Animals

Spiders, tiger beetles, antlions, grasshoppers, termites, digger wasps, and various species of beetles and flies are the typical residents of the beach and foredune areas. Few species of vertebrate animals other than gulls and shorebirds utilize these areas.

Amphibians and Reptiles

Amphibians and reptiles are not likely to be present in the two parks, but may be present in the disturbed areas in the vicinity of the site. Fowler's toad may be associated with the beach community, but no individuals of this species have been observed in Illinois Beach State Park, and it is unlikely that they are present in the harbor area. The American toad and the eastern hognose snake probably are present in the moist areas to the west and north of North Beach.

Mammals

Because mammals are more mobile than amphibians and reptiles, a few species may be present in the project area at some time during the year. However, the relative scarcity of vegetation and the amount of human activity in the vicinity would tend to cause them to avoid the area except during the early morning and evening. It is likely that prairie deer mice, eastern cottontails, and other small mammals are present in the Waukegan Harbor area, primarily along the northern end of North Beach. Skunks, raccoons, and other predators may visit the area periodically. Muskrats currently use lodges in the marsh on the Commonwealth Edison property, but these animals are not likely to enter the beach areas in the vicinity of the harbor.

Birds

The shore of Lake Michigan serves as a natural migration route and resting area for birds. Many species pass through the Waukegan Harbor area during spring and autumn migration periods and stop to rest on the beach at North Beach Park, on the breakwaters, or in the calm water area between the breakwaters. Other species, such as the black tern, come to the harbor for the summer after breeding in inland areas. Some species such as gulls also over-winter in the harbor area. At least 152 species of birds have been observed in the vicinity of Waukegan Harbor. Twenty-seven of these are fish-eating species, 10 of which reside in the harbor area during the summer or the winter.

A breeding colony of common terns, which are classified as endangered in Illinois, is present on the Commonwealth Edison property immediately north of the harbor area. Approximately 40 adult black terns and 2 juveniles (a species also classified as endangered in Illinois) were observed during a field visit by WAPORA personnel on July 19, 1981. The adult terns were roosting on the north breakwater at the entrance to the harbor and presumably were feeding on fish from the harbor area.

The gulls in the harbor area generally use North Beach as a day roost. They roost on the beach overnight and during the early morning, and then move out to the lake after people begin to arrive at the beach.

Because of the number of migrating species and the ease of observation of the birds from the pier that extends for a considerable distance into Lake Michigan, the harbor is a favorite observation area for local birdwatchers, especially during the spring and autumn migration periods. Many species of shorebirds have been observed along the shoreline to the north of the harbor, up to Illinois Beach State Park. North Beach may be too disturbed to attract most of these species.

Of the three habitat types (marshes, shores, and open water) accessible to birds in the Waukegan Harbor area, the open water habitat of the harbor and Lake Michigan is by far the most extensive. The species that utilize this habitat type, such as ducks, mergansers, and gulls, have the largest populations.

Threatened or Endangered Species--Federal Classification

The bald eagle, classified as endangered by the U.S. Department of the Interior, has been observed in the Waukegan Harbor area during migration periods. No other species of terrestrial biota currently listed as endangered or threatened is known to be present in the area at any time during the year.

Threatened or Endangered Species--State Classification

Fifteen species of birds and at least five species of plants classified as endangered in Illinois are known or likely to be present in the project area. Two species of birds and one species of plant classified as threatened in Illinois also have been observed in the Waukegan Harbor area.

Although the range of the spotted turtle may include some parts of Illinois Beach State Park, and yellow-headed blackbirds have been observed in the marsh to the east of the Commonwealth Edison cooling ponds, neither species has been observed in the Waukegan Harbor area. Both species are classified as endangered in Illinois. Nineteen species of birds have been included on the Blue List of the National Audubon Society for 1981. This is an early warning list of species that are determined to be declining, threatened, or vulnerable on the basis of nominations from knowledgeable observers in all regions of the United States.

AQUATIC BIOTA

Many researchers have studied the chemical and biological components of the aquatic habitats of harbors located along the shores of Lake Michigan. Most have reported that the harbors often were severely degraded. Harbors and other partially enclosed areas are very susceptible to environmental degradation because of inputs from adjacent population centers and industrial processes. This effect is further compounded by the limited water exchange (dilution) with the open lake.

Fish

Data from 1971 studies by Industrial Bio-test Laboratories, Inc., indicate that, in general, alewife, lake trout, rainbow smelt, bloater, coho salmon, brown trout, lake whitefish, and yellow perch were the most abundant species within the Waukegan-Zion area. (Detailed temporal and spatial variations for each of these species are discussed in the WAPORA document (048).)

Benthic Macroinvertebrates

Benthic macroinvertebrates are defined as those visible organisms that inhabit and are a part of the bottom zone of a water body. Benthic macroinvertebrates are considered to be important secondary producers or consumers when assessing potential impacts because the organisms are relatively immobile; thus, the community composition, abundance, and distribution of these organisms are a reflection of aquatic conditions in the recent past. These characteristics of the benthic community are determined by the oxygen content of the waters, sediment composition, the degree and type of pollutants (organic, inorganic), scouring by wave action, and other factors.

In the food web, benthic macroinvertebrates are secondary consumers of detritus, plankton, and other invertebrates, as well as a significant source of food for fish. It is through this food source that PCBs generally are considered to move into fish.

The composition of the macroinvertebrate community near Waukegan, as determined in a 1974 study by Limnetics, Inc., was dominated by aquatic worms, freshwater shrimp, flies, and midges. Snails, clams, sow bugs, and water mites also were present, but in lesser numbers. Most of the organisms present are considered by researchers to be either facultative (found in moderately polluted waters and having a wide range of tolerance of organic pollution) or tolerant (capable of thriving under grossly polluted conditions).

Limnetics, Inc., also calculated diversity and equitability. Diversity is a measure of the species richness and the distribution among species; the greater the diversity, the better the condition of the aquatic population. Equitability is a measure of the component of diversity affected by the distribution of individuals among species. Equal numbers of all species present results in an equitability value of 1.0; values greater than 0.8 are indicative of unpolluted conditions. Limnetics, Inc., reported that for the shallow locations sampled, diversity ranged from 0.000 (only one species found) to 2.3875 and that equitability ranged from 0.000 to 0.9284. It should be noted that the use of these indices is hindered by naturally low diversity in Lake Michigan and is further hindered in this case by severe stress from wave action in shallow, unstable areas.

Phytoplankton

Phytoplankton occupy a unique position in the ecosystem of Lake Michigan. They represent the transition stage from the physical and chemical aspects to the higher-order biological communities. Thus the phytoplankton community can act as an early warning indicator of changes in the chemical nature of the aquatic ecosystem.

Several intensive studies designed to detect seasonal changes in species composition and abundance were conducted in southern Lake Michigan in the 1960s and 1970s. Industrial Biotest Laboratories, Inc., sampled phytoplankton communities at several locations near Waukegan and Zion in 1972. The following results were obtained:

- Diatoms were the most predominant group, constituting 60 percent of the biovolume.
- Blue-green algae constituted 26 percent of the biovolume.
- Green algae had the highest species diversity and constituted 31 percent of the species present.

The inshore location nearest to Waukegan produced the highest densities of green algae and of all phytoplankton; this was the result of extremely high concentrations of the diatoms *Tabellaria flocculosa* and *Fragilaria crotonensis*.

Zooplankton

Zooplankton represent an important link in the nutrient cycling and energy flow through an aquatic environment. Zooplankton graze on phytoplankton and serve as a source of food for many invertebrates and fish. The following summary is based on data from 1971 and 1974 studies by Industrial Bio-test Laboratories, Inc., and Limnetics, Inc., respectively.

A single seasonal maximum was noted; populations were relatively low from January through May, peaked in August, and then declined. Copepods comprised more than 80 percent of the total zooplankton during the winter and spring. Rotifers accounted for 50 percent of the total during the early summer. Cladocera were the predominant (50 percent) organisms during August. The numerically predominant species included *Bosmina longirostris*, *Cyclops bicuspidatus thomasi*, *Daphnia retrocurva*, *Diaptomus ashlandi*, and *Diaptomus minutus*.

Threatened and Endangered Species

No species of fish classified as endangered or threatened by the U.S. Department of the Interior are known to inhabit the Waukegan area. No species classified as endangered by the State of Illinois have been collected in the Waukegan area. Three species of fish classified as threatened in Illinois (cisco, longnose sucker, and lake whitefish) were collected in limited numbers in the area in 1971. Of these, only the lake whitefish was reported, in 1978 and 1979 studies, to have occurred in the Waukegan-Zion area in recent years. These studies reported that only limited numbers of lake whitefish were present.

LAND USE

The existing land use in the City of Waukegan in the vicinity of the project area is largely industrial, with a number of commercial, open space and recreational, and other public land uses. All of the land uses east of the Eastern, Joliet, and Elgin Railroad line are water-related or water-dependent activities that must be located close to Lake Michigan. These activities include industrial uses that require waterborne transportation; commercial uses that serve boating, fishing, or other recreational activities; and municipal uses, such as the public beach, the wastewater treatment plant, and the water filtration plant, that derive their functionality from the lake.

Nearly the entire harbor is surrounded with industrial or heavy commercial uses, including OMC, Goldbond Building Products, Huron Cements, and the Waukegan Port District. The only remaining open space around the harbor is owned by OMC. Other land uses within the project area include Larsen

Marine Services, Falcon Marine, the City of Waukegan Water Filtration Plant, the North Shore Sanitary District (NSSD) Wastewater Treatment Plant, and public beach and beach house facilities along the full extent of the publicly owned Lake Michigan shoreline.

There are ten public boat launching ramps at the south end of the harbor. A boat hoist also is available at Larsen Marine adjacent to Slip No. 3. Because Waukegan Harbor is the only protected public harbor on the northern Illinois shoreline (public access to Great Lakes Harbor to the south is restricted to boat owners renting moorage space from the U.S. Navy) and a large number of boat launching ramps are available, Waukegan Harbor supports a large amount of recreational boating activity and attracts boaters from throughout Lake County, Illinois, and from Kenosha County, Wisconsin.

In 1980, the City of Waukegan developed three major land use objectives to be considered in the establishment of a land use plan:

- To improve public health and welfare through reductions in air, noise, and water pollution
- To conserve the natural resources of the area
- To protect existing scenic areas and to create new scenic areas

The City's plans to encourage recreational and open space land use along the Lake Michigan lakefront, including the Waukegan Harbor area, are consistent with these objectives.

POPULATION

The City of Waukegan is the most populated municipality in Lake County. The official 1980 Census figure is 67,653. From 1970 to 1980, population growth in Waukegan (3.2 percent) was markedly slower than in Lake County as a whole (15.1 percent). Population projections for the City of Waukegan for the year 2000 range from 87,269 to 111,301. Currently, all of the residential development in Waukegan is located outside of the harbor area. This development trend is expected to continue because no land in the harbor area is zoned residential, and little land in the area is suitable for residential development.

EMPLOYMENT

The Waukegan Harbor area is the major industrial center in the City of Waukegan and is an important component of the industrial district located along the shore of Lake Michigan between North Chicago and Waukegan. Currently, the 15 publicly and privately owned establishments located in the harbor area employ 12 percent of the persons employed in Waukegan. The total number of jobs in the harbor area is approximately 3,500.

Unemployment in the City of Waukegan was high during 1980. The unemployment rate of 9.8 percent was higher than the Lake County rate of 6.9 percent, the Illinois rate of 8.3 percent, and the national rate of 7.1 percent. This rate may reflect the concentration of Waukegan employment in manufacturing industries that have experienced slow growth during recent years.

ECONOMIC ACTIVITY

A cursory survey of the employers in the harbor area indicates that much of the economic activity either is water-dependent or water-related. The Outboard Marine Corporation, Larsen Marine, Falcon Marine, Waukegan Port District, Waukegan Yacht Club, and Waukegan Water Filtration Plant depend upon the harbor and Lake Michigan for their operations. Huron Cements and Goldbond Building Products also depend upon a working harbor for their operations.

Industrial activity in the Waukegan Harbor area is expected to remain stable with little expansion. The value of land in the harbor area for recreation and open space uses will increase. Planned industrial growth will be directed to the west of the harbor area. Employment is expected to remain concentrated in manufacturing industries. Increases in the retail, transportation and utilities, and miscellaneous services sectors also are expected.

TRANSPORTATION FACILITIES

Port Facilities

The Waukegan Harbor is a 14-acre interior basin with a 200-ft-wide, 19-ft-deep channel. The harbor facilities are maintained and operated by the Waukegan Port District and are used for both recreational and industrial purposes. The harbor is open from April 15 to November 15. The harbor facilities provide the Waukegan area with access to world markets. The majority of the harbor traffic, however, consists of pleasure boats. There are more than 750 20-ft to 40-ft pleasure boats moored in the harbor. An expansion of the harbor is underway and will add 750 public mooring slips.

Highway Facilities

The road network near Waukegan is comprised of publicly and privately owned roads. Interstate Highway 94 is located approximately 6 miles west of Waukegan Harbor, and the nearest interchange is at Grand Avenue (Route 132). The City of Waukegan has established a truck route system with eight designated truck routes. The truck routes are heavily traveled, but substantial additional capacity is available.

Railroad Facilities

The Chicago and North Western Transportation Company (C&NW) and the Elgin, Joliet, and Eastern Railroad Company (EJ&E) operate freight lines in the western portion of the harbor area. In general, operations on both sets of tracks are light and therefore do not interfere with automobile traffic patterns.

RECREATION AND TOURISM

Many types of recreation facilities and opportunities are available at Waukegan Harbor. The Illinois Department of Conservation, Division of Fisheries and Wildlife, has estimated that Waukegan Harbor and offshore areas experience the heaviest fishing pressure of any area along the Illinois coastline of Lake Michigan. In addition to fishing, a substantial number of people use the Waukegan Harbor for sailing, picnicking, or sightseeing. The beach to the north and east of the harbor is used for swimming, sunbathing, volleyball, and public events. Recreational facilities in the harbor area in addition to the boat mooring and public launching areas include the Waukegan Yacht Club, the Warren G. Sivert Park, and the south breakwater.

The City sponsors five festivals each year at the public beach. In 1981, between 70,000 and 80,000 people were expected to attend these festivals. Because there are only 250 public parking spaces available at the beach, the City has an informal arrangement with OMC to use the vacant area across from the beach for parking for the festivals. Approximately 2,500 cars can be accommodated in this area.

SEWER AND UTILITY LINES

Storm and Sanitary Sewers

The North Shore Sanitary District (NSSD) and the City of Waukegan provide storm and sanitary sewers in the project area. The system in the vicinity of the North Ditch consists of a 54-inch-diameter gravity sanitary sewer, a 48-inch-diameter gravity combined sewer, and a 54-inch-diameter force main. These sewers are located parallel to each other in an east-west direction just north of the south property line of the NSSD Waukegan treatment plant, which parallels the North Ditch. A sanitary sewer traverses the vacant lot owned by OMC in the vicinity of the proposed lagoon construction site. Another sewer runs north from the water filtration facilities near the harbor mouth along the beach to the NSSD treatment plant. This sewer was installed in 1978 to carry filter-backwash solids away for treatment and disposal.

Water Lines

No water mains exist in the immediate vicinity of the North Ditch. There is a 24-inch water main in the right-of-way of Seahorse Drive. Individual service lines extend from this main.

Natural Gas Lines

The North Shore Gas Company provides natural gas to the project area. The system consists of a 12-inch-diameter gas main located along the private road that extends from the northwest corner of the OMC property east and south to Seahorse Drive. The main continues along the north-south section of Seahorse Drive to the Waukegan Water Filtration Plant. Two vault regulators are located south of the east-west section of Seahorse Drive on the vacant OMC property.

Electrical Lines

Commonwealth Edison provides electrical service to the project area. Underground and overhead facilities are located in the vicinity of the North Ditch. Underground facilities are located in the harbor itself and on the vacant parcel of land owned by OMC.

Telephone Lines

The Illinois Bell Telephone Company provides telephone service to the project area. Most of the telephone cables are located in street rights-of-way. Service cables extend to individual properties.

CULTURAL RESOURCES

No landmarks on the National Register of Historic Places are located in the harbor area, and no historical or archaeological sites are known to exist there.

According to the Waukegan Historical Society, five sites of local significance are located in the harbor area: a memorial shelter at Leisure Park, a memorial boardwalk, a bandshell that was constructed through the efforts of the Waukegan Exchange Club, a historical marker that commemorates five explorers who were present in the Waukegan area during the 1670s and a beach pavilion presented to the people of Waukegan in July 1940. The bricks used in the front pillars of the pavilion came from the old Waukegan lighthouse, which was razed in 1938.

PART 2: IMPACTS OF NO ACTION

SLIP NO. 3

The No Action alternative will leave PCB concentrations in excess of 10,000 ppm in the localized area of Slip No. 3 near the former OMC outfall and concentrations in excess of 500 ppm in the rest of Slip No. 3 sediments. This represents an estimated 305,200 lb of PCBs (008, 016). PCBs in these concentrations are regulated by 40 CFR 761 under TSCA. Approximately 98.4 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor are located in Slip No. 3.

Without cleanup, Slip No. 3 will continue to contribute to the estimated 22 lb of PCBs released into Lake Michigan each year from Waukegan Harbor water (based on a steady state model) (035). The Waukegan area will continue to represent the most significant contributor to Lake Michigan PCB contamination, since it holds the largest known uncontained PCB mass in the lake basin. The potential for volatilization of PCBs will continue, contributing to the estimated 12 to 40 lb of PCBs that are released from the harbor into the local airshed each year (007, 030).

UPPER HARBOR

The No Action alternative will leave PCB concentrations between 50 and 500 ppm in the Upper Harbor sediments. This represents an estimated 5,000 lb of PCBs (008, 016). PCBs in these concentrations are regulated by 40 CFR 761 under TSCA. Approximately 1.6 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor are located in the Upper Harbor.

Measured concentrations of total PCBs in the water column range from 0.6 ppb in the Upper Harbor to less than 0.01 ppb in the Lake region directly offshore from the harbor (035).

Without cleanup, the Upper Harbor PCBs will continue to contribute to the estimated 22 lb of PCBs released into Lake Michigan each year from Waukegan Harbor water. The potential for volatilization of PCBs would continue, contributing to the estimated 12 to 40 lb of PCBs that are released from the harbor to the local airshed each year (007, 030).

NORTH DITCH

The No Action alternative will leave an estimated 495,500 lb of PCBs in the North Ditch area soils. Concentrations in excess of 10,000 ppm are in a localized area of the Crescent Ditch and Oval Lagoon, and concentrations between 50 and 10,000 ppm are in the rest of the North Ditch soils (001, 057). PCBs in these concentrations are regulated by 40 CFR 761 under TSCA.

Average water column PCB concentrations in the North Ditch were reported to be about 7 ppb with peak values during rainfall events of 80 to 160 ppb (035).

Without action, offsite drainage entering the North Ditch will continue to become contaminated, discharging PCBs into Lake Michigan. Groundwater resources will continue to be contaminated. It is estimated that 7 to 20 lb of PCBs are discharged annually into Lake Michigan from the North Ditch (032, 035).

Volatilization estimates for newly exposed contaminated sands with levels of 1,000 ppm PCBs are 5,375 ug/m²/hr. The volatilization rate will decrease with time as the PCBs near the surface are volatilized (007). Existing air contamination from North Ditch waters is estimated at 15 lb/yr (004).

PARKING LOT

The No Action alternative would leave an estimated 277,700 lb of PCBs in the soils under the Parking Lot in concentrations from 50 to over 5,000 ppm (001). PCBs in these concentrations are regulated by 40 CFR 761 under TSCA.

The groundwater is within 3 ft of the surface of the Parking Lot area, resulting in contamination of this water. It is estimated that the slowly moving water will begin releasing some 8 lb per day of PCBs into Lake Michigan in approximately 60 years (048). This will result in further contamination of local water and soil, which will continue for decades thereafter.

Although volatilization of contaminated soil in the Parking Lot area does not appear to be occurring now because it is paved, the potential exists if the soil is disturbed. Grading, trenching, drilling, digging, or other activities necessary for utility installation, drainage, or other construction projects could cause volatilization of PCBs.

IMPACTS ON FISH

The USEPA Ambient Water Quality Criteria for protection of freshwater aquatic life from PCB chronic toxicity is 0.014 ppb (088). The lowest reported toxic concentration for freshwater aquatic life for PCB acute toxicity is 2.0 ppb (085). Total reported PCB concentrations in surface water at the OMC site range from about 7 ppb or more in the North Ditch and 0.6 ppb in Waukegan Harbor to less than 0.01 ppb in Lake Michigan directly offshore from Waukegan Harbor. About 60 percent of the total harbor PCBs in the water column is in the dissolved form. The water column PCB concentrations vary over a range of about 1.5 to 2.0 orders of magnitude (035).

Fish accumulate PCBs in their tissues by uptake from the water in which they live and by ingestion of aquatic organisms, insects, and plants that have taken up PCBs from their environment. It has been demonstrated that fish bioaccumulate PCBs to factors of 100,000 or more times the ambient water concentrations of PCBs. Available data indicate that PCBs are not excreted or degraded but are stored in skin and adipose (fatty) tissue. In USEPA studies on Lake Michigan fish, results ranged from concentrations of 2.7 ppm to 187 ppm PCB in fatty tissue for all species. PCB concentrations in excess of 5 ppm were present in all trout and salmon more than 12 inches long. Positive correlations between size of the fish, percent fat, and age and the concentration of PCBs dissolved in the water column have also been found. Therefore, larger fish with a higher percent fat content, such as salmon and trout, accumulate high concentrations of PCBs. Bottom feeders, such as carp, also accumulate very high PCB concentrations from contact with PCB-contaminated bottom sediments (002, 021).

Bioaccumulation has been shown to occur at positions higher in the food chain. Carnivorous predators, such as largemouth bass, have markedly higher PCB concentrations than species lower on the food chain (002, 021).

Research has also shown that PCBs interfere with growth and reproduction of several species of fish. PCBs in the water column have been shown to inhibit phytoplankton photosynthesis, which will limit the growth of fish that require phytoplankton as a food source. High PCB concentration in bottom sediments may interfere with the development of eggs that are deposited on the bottom during spawning. Fish fry mortality has a direct correlation to PCB levels in the water column, thereby artificially reducing fish populations. PCBs may ultimately act to diminish natural populations of fish species (002, 021, 049).

IMPACTS ON ANIMALS

The No Action alternative would result in a continued increase in the concentrations of PCBs in the fish-eating birds, waterfowl, shorebirds, and other species of terrestrial animals that live and feed in the vicinity of Waukegan Harbor and in nearby parts of Lake Michigan. The PCB masses would remain in the area for many years, and the PCB loading to the lake would increase during the period required for the complete dispersal of PCBs from the contaminated areas into the lake. The concentrations of PCBs would increase in the individual animals that routinely or periodically ingest highly contaminated food items. The individuals that reside in the area during a significant part of the year, such as gulls, terns, and diving ducks, would be most affected. Migratory species that rest and feed in the area for a short period of time during the spring and the autumn would be less likely to accumulate large burdens of PCBs, although the body burden of an individual bird would increase after each annual visit. Because these birds also might ingest PCB-contaminated food items in other parts of their ranges, the total body burden of an individual bird of a relatively long-lived species could be sustained or increased to a level that would affect its reproductive potential, the viability of its young, or its own health (048).

PCBs are known to accumulate in fatty tissues, and migratory birds develop additional fat deposits in their bodies as an energy reserve prior to migration. When fatty deposits containing PCBs are metabolized, the PCBs are released into the bloodstream and can have various toxic effects on the individual organisms or their offspring. Rapid releases into the bloodstream could result from acute, short-term stresses such as flight from a predator or severe weather conditions or from continuous, longer-term stresses such as those associated with migration and reproduction, when large amounts of energy are required (048).

The long-term effects of a relatively stable chemical stressor such as PCBs, especially in a situation where the dispersal of the contaminant is more than offset by a continual fresh input, is not yet known. Species vary in their tolerance to chronic "contamination stress," and many would be more susceptible to toxic effects from manmade compounds when stress from these sources is combined with stresses from other natural or manmade sources such as migration or synergistic effects from simultaneous accumulation of DDT. The major long-term effects of contaminant-induced changes in behavior or reproduction would become evident at the population or community level. Little knowledge currently exists on the ability of species, populations, or communities to resist and recover from such stresses. Because PCBs are manmade compounds, few organisms have evolved that have the capacity to break them down into harmless constituents such as carbon dioxide and water-soluble compounds (048).

Skin disorders such as facial edemas, hair loss, and acne have been observed in monkeys given oral doses of PCBs. PCBs applied directly to the skin of rabbits produced hyperkeratosis, erethyma, blisters, and desquamation. PCB exposure in primates resulted in prolonged menstrual cycles and increased bleeding, indicating endocrine effects (087). Other symptoms reported in various species include: gastric hyperplasia, thymic atrophy, decreases in red blood cells and lymphocytes, splenic atrophy, an increase in the serum level of triglycerides, chloresterol and phospholipids (087), swelling of livers and jaundice, enzyme system disturbances, growth inhibition, decrease in immunosuppression, and decreased in reproduction (086, 087).

IMPACTS ON PUBLIC HEALTH AND SAFETY

The magnitude of PCB effects on human health are not yet known. However, a severe accident involving PCB contamination of rice oil occurred in Kyushu, Japan, in 1968, implicating PCBs as a health hazard. The Japanese called the accident Yusho (oil disease). The oil contained PCB concentrations between 2,000 and 3,000 ppm, now known to be in combination with chlorinated dibenzofurans and quaterphenyls (049, 065). Health effects were documented in more than 2,000 persons. Consumption of the contaminated oil resulted in skin lesions, blindness, hearing loss, jaundice, and abdominal pain. Uterine ulcers, stillbirths, and miscarriages also occurred. Infants born to mothers exposed to the contaminated rice oil exhibited skin, gum, and fingernail discoloration, indicating that at least some of the contaminants had crossed the placental membranes. Other symptoms of toxicity noted in humans include: swelling of joints, waxy secretion from eyelid glands, general lethargy, joint pain, weakness and vomiting, abnormal menstrual cycles, and weight loss (085, 086, 087, 002, 021, 049).

Occupational exposure to PCB mixtures has caused chloracne and liver injuries in workers exposed to low levels. PCB effects on worker health from occupational exposure have also been documented (049, 002, 021).

Documented occurrences of high levels of PCB contamination in humans have almost all resulted from consumption of contaminated foods, accidentally or through accumulation in fatty tissues through the food chain. Inhalation of and skin contact with PCBs are not considered a significant source of contamination for the general public, but they are of concern in occupational exposure. The OSHA standard (29 CFR 1910) for an 8-hour work shift exposure to PCBs in air is 1.0 mg/l for PCBs with 54 percent chlorine (Aroclor 1254) and 0.5 mg/l for PCBs with 42 percent chlorine (Aroclor 1242). Samples taken by the Environmental Research Group, Inc. (ERG) on September 3, 1980, for USEPA detected Aroclor 1242 and Aroclor 1248 in Waukegan Harbor sediments. Aroclor 1254 was below detection limits (079).

USEPA Ambient Water Quality Criteria for carcinogenicity protection of human health from ingestion of water and organisms is 0.00079 ppb at the 10^{-5} risk level. Concentrations that have a risk level of 10^{-5} are estimated to result in an increase of one cancer death per 100,000 people who experience exposure over a lifetime. Total PCB concentrations vary from 0.6 ppb in Waukegan Harbor to less than 0.01 ppb in Lake Michigan directly offshore from Waukegan Harbor (035). There is an emergency water supply intake for Waukegan near the mouth of the harbor.

SOCIOECONOMIC IMPACTS

The Lake County Health Department, in conjunction with the State of Illinois, has posted warnings of high PCB concentrations in fish taken from Waukegan Harbor. Commercial fishing is restricted. Economic losses to Waukegan area may occur because of the lowered recreational fishing demand and restrictions on commercial fishing, and associated expenditures such as lowered charter boat demand, lower pleasure boat usage, and lower overall recreational and/or tourist potential for the area. The PCB problem also might impact the desirability of the lake, harbor, and project area as a place to do business (002).

Harbor maintenance dredging of PCB-contaminated soils is expensive because of the disposal and handling requirements for dredged sediments with concentrations greater than 50 ppm. Huron Portland Cement and National Gypsum are now and will continue to be directly impacted, since they depend on the harbor to receive raw material shipments.

A summary of the socioeconomic effects from PCB contamination of surface-water bodies, sediments, and soils in the Waukegan community might include:

- Loss of fish for human consumption
- Reduction or loss of commercial fishing
- Decline in property values
- Depressed area growth
- Reduction in recreational activity, such as boating and sport fishing
- Reduction in commercial harbor access due to lack of harbor dredging
- Expenditures for laboratory analysis of area water, soil, and biota samples
- Occupational exposure
- Expenditures for medical services
- Expenditures for legal services

PART 3: IMPACTS OF ALTERNATIVES

SLIP NO. 3

Alternative 2B: Dredge-Dewater in Lagoon-Fix-Dispose

Response Objectives

This alternative would remove all sediments from Slip No. 3 with PCB concentrations greater than 50 ppm. If a 95 percent removal efficiency were achieved, it would remove an estimated 290,000 lb of PCBs contained in approximately 10,900 yd^3 of sediments. This would remove about 93.5 percent of all the PCBs now found in the Slip No. 3 and Upper Harbor area (003).

Mathematical modeling conducted by HydroQual, Inc. (035), indicates that dredging of the harbor sediments to a level of 50 ppm PCB would reduce peak water column concentrations by approximately one order of magnitude (to less than 0.1 ppb) and fish body burdens to less than 5 ppm. Since this alternative would remove approximately 93.5 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor, results are expected to be similar to reductions predicted by the model. Removal would also significantly diminish the existing estimated volatilization rate of 12 to 40 lb/yr of PCBs released from the harbor into the local airshed by approximately an order of magnitude (007).

All former land and water uses would be able to resume after cleanup activities are completed. No restrictions to future uses would be expected.

Duration of Cleanup Activities

Dredging and related activities for Slip No. 3 would require about 2 months. An additional 2 months would be required for dredging and related activities in the localized area requiring dredging of deep contaminated sand and silt. If the water treatment plant were not protected against freezing weather, the dewatering lagoon would not be able to release slurry water to the plant during freezing conditions. Dredging would then have to occur during nonfreezing weather.

Solids removal to the batch plant would begin about 2 months after dredging activities are completed. Removal and fixation of the dewatered sediments would require 2 to 3 months. Offsite transportation to the disposal site would be concurrent with the fixation process. Total project duration is estimated to be 10 months.

Impacts and Mitigation of Cleanup Activities

Dredging. Roiling of bottom sediments during dredging results in sediment suspension and dispersion. The use of a hydraulic dredge and the proper dredge head would minimize roiling and sediment dispersion. A sediment dispersal control system (double silt curtain or steel sheet piling) would also be employed to minimize migration of suspended PCBs out of the dredging area. To assist in controlling sediment dispersion, water would be continually pumped from inside the slip during construction to maintain net inflow at the slip mouth. This would tend to keep sediments from crossing the control barrier. The water could be treated by addition of polymer and/or activated carbon before the sediment barrier is removed.

A program would be established to monitor the effectiveness of the containment measures and to warn of the need for polymer addition or shutdown of dredging. A seiche warning arrangement with the National Weather Service would also be put in place so operations could be suspended if a seiche were imminent. The containment devices would be most likely to fail during a seiche due to the forces created by a sudden difference in water level between the two sides of the sheet piling or double silt curtain.

A clamshell dredge may be required in the localized area of Slip No. 3 to remove the deep contaminated sediments (sand and silt) below the muck at the former OMC outfall. Spillage of 15 to 30 percent of the sediments in a clamshell bucket occurs while it is being raised. This spillage would create a high degree of sediment suspension that would increase the concentration of PCBs in solution. A sheet pile cofferdam would be employed to support the excavation sides and contain these dredging activities. The water would be treated by the addition of powdered activated carbon to remove dissolved PCBs before the cofferdam sediment barrier was removed. The water level inside the cofferdam would be lowered to create net inflow as an additional control measure.

The City of Waukegan maintains an emergency water intake in Waukegan Harbor. This water intake, while an integral part of the Waukegan Harbor system, is rarely used. Project activities would be expected to be completed while the intake was not in use. If, however, the intake was needed during project activities, a monitoring program, including sampling of raw and finished water, would be established during the project to ensure the safety of the supply. A contingency plan would also be established to stop project operations if any contamination entered the system.

Larsen Marine Services would be adversely affected by any dredging that inhibited or cut off access to its docks. These impacts would be short-term and could be minimized by scheduling dredging during periods that would cause the least impact on Larsen Marine Services.

Minimal volatilization would be expected to occur during dredging activities. Losses would be expected to be roughly 0.3 to 0.4 lb/day/acre from the exposed, agitated, and contaminated water area (030). Concentrations of less than 2 ug/m^3 would be expected to be present in the air as a result of dredging activities (007). By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m^3 in the air at any time. However, the National Institute of Occupational Safety and Health (NIOSH) recommends that workers not be exposed to more than 1 ug/m^3 in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

The proposed dredging would affect terrestrial biota. Populations of gulls and terns that currently reside and feed in the vicinity of the harbor would be disturbed by increased noise and activity levels and may move to another area along the shoreline of Lake Michigan during the times of the day when disturbances would occur. However, because none of these species breeds in the immediate vicinity of the harbor, no long-term displacement of populations is anticipated (048).

Some species of birds or other animals could come into contact with the contaminated sediments and water in the harbor and dewatering lagoon, particularly during non-working hours (gulls) and autumn migration periods (waterfowl and shorebirds) (048).

Changes in the harbor water column PCB concentrations and reduced PCB accumulations in fish would be the two principal long-term beneficial impacts of dredging.

Possible short-term adverse impacts of dredging would include the following:

- The area inside the sediment dispersal control device used to detain roiled sediments would become turbid during dredging and would very likely become anoxic in the pre-dawn hours following a day of dredging in organic "muck" sediments. Indications are that "disturbances" of polluted bottom sediments, especially if they have great quantities of reduced compounds dissolved in the interstitial waters, can elevate the expression of sediment oxygen demand by as much as one order of magnitude. Diurnal rhythms of respiration/photosynthesis in freshwater algae are such that the lowest oxygen levels occur in pre-dawn hours. Consequently, almost all respiring organisms inside the silt curtains would be driven out or may die during early morning hours after dredging (048).

- If dredging occurs during the fall and spring, there is a good chance that spawning fish may be present in the harbor during the dredging activities. Chinook making fall runs may be able to swim around or leap over the silt curtains into a highly PCB-laden body of water (048).

Dewatering. Construction of a dewatering lagoon and treatment facilities on OMC property or another nearby site would remove this land from other uses for the duration of the project.

The lagoon would be constructed with impermeable clay liners and a leachate collection system. The groundwater beneath the lagoon would be monitored by test wells to detect leakage from the lagoon.

Some volatilization of PCBs would occur during dewatering. Volatilization would be minimized during initial placement of the dredged sediments by the decanting water layer. This would reduce the estimated volatilization rate from 2 lb PCBs per day (for exposed sediments with a typical concentration of 1,000 ppm) to less than 1.0 lb PCBs per day from the less contaminated (100 ppb) decanting water layer (007, 030). Other measures that could be employed include: (1) placing the less contaminated sediments on top of the more contaminated sediments during dredging; (2) placing a layer of an organic material (e.g., digested activated sludge, manure) on top of the dewatering sediments upon completion of dredging; or (3) placing a synthetic liner on top of the water in the lagoon during and following dredging. These measures would be expected to keep PCB concentrations in the air above the lagoon at about 2 ug/m³ (007).

<u>Water Treatment</u>. All PCB-contaminated water (supernatant from initial solids dewatering, leachate, rainwater, and monitoring well water collected from the lagoon) would be processed through a package water treatment plant. The water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct the water quality analyses. Effluent would be discharged to the harbor or to a sanitary sewer. Water discharged to the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

<u>Solids Removal, Fixation, and Disposal</u>. Volatilization would be expected to occur during solids removal from the lagoon and truck loading for transport to the batch plant. The highest reported concentration in a Slip No. 3 sediment sample is about 500,000 ppm (008). The maximum predicted PCB concentration in the air from solids removal operations is predicted to be less than 200 ug/m³ for sediments with concentrations of 100,000 ppm PCBs (007). These values were extrapolated from data for sand assuming a 3.6-mph wind and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

Dewatered sediment would be fixed into a nonflowable form for offsite transport by truck. A sufficient amount of fixing agent would be used to prevent water loss, and covers may be required to prevent volatilization during transport. Rules and regulations controlling the transport of hazardous materials promulgated by the United States Department of Transportation (USDOT), USEPA, IDOT, Illinois Institute of

Natural Resources (IINR), and other applicable regulatory agencies would be complied with. These include cleanup, safety, and spill prevention and response measures.

Offsite disposal of fixed dredged sediments, volatilization material, and liner material would require approximately 1,880 truck trips to the disposal site using a 10-yd³ capacity truck. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic, but some roadway congestion and roadway damage could occur (048). Some species of terrestrial animals could come into contact with contaminated materials if any loss occurs during transport, and the contamination could be passed into other terrestrial food chains (048).

Disposal of the materials would be in a licensed chemical waste landfill, and would be in compliance with State and Federal standards for PCB waste disposal. PCB materials with concentrations greater than 50 ppm must be nonflowable if they are to be disposed of in a licensed chemical waste landfill (40 CFR 761). Solids dewatering and/or fixation must be complete enough to result in a nonflowable consistency after transport for final disposal.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, dredging, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Recreation. The noise and traffic congestion associated with construction activities could have short-term negative impacts on the public beach adjacent to the project area.

The City of Waukegan uses the site proposed for the dewatering lagoon as a parking area for its public festivals. This alternative would preclude this use for the project duration. The city would have to arrange other transportation means (such as a shuttle system between the downtown area and the beach) because no alternative parking facilities are available.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (see Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities and the holding lagoon. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Dredging. Both hydraulic and clamshell dredges have been widely used in the past for dredging. No new technologies are proposed to complete the dredging. Dredging technology is well developed, and the reliability of the equipment to remove sediments from the slip and transport them to the lagoons is high. If a stoppage of the hydraulic dredge occurs during dredging, it is expected to result in some temporary additional suspension of sediment in the water column because of interruption in hydraulic flow. Leakage or rupture of the hydraulic dredge discharge pipeline could disperse PCB-laden water and sediment over previously uncontaminated areas along the pipeline. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill. A contingency plan would be established for prompt cleanup. Leakage could either be eliminated by pipe joint tightening or be controlled by joint caulking, mats, collection containers, or similar means. The collected solids could be disposed of with the PCB-contaminated solids, and collected water could be taken to the water treatment plant.

Dewatering Lagoon and Curing Cells. The technology for construction of lined lagoons is well developed and feasible. There are no unusual construction details for the lagoon construction. Construction could be accomplished using conventionally available materials and equipment. The risk of failure would be low. If the upper clay liner failed, contaminated leachate could be collected by the underdrain system. If the lower clay liner also failed, contaminated soil would have to be excavated and disposed of with the other contaminated solids.

If an exterior lagoon dike failed, PCB-contaminated water and sediment could flow over a large area, requiring substantial cleanup operations and causing greatly increased volatilization. The technology for dike design is well understood, however, so the probability of dike failure would be extremely low.

If an exterior curing cell dike failed while a cell was filled with incompletely cured fixed solids, PCB-contaminated water and sediment could flow over a small area, requiring cleanup operations and causing slightly increased volatilization. The technology for dike design is well understood, however, so the probability of dike failure would be extremely low.

If detention in the lagoon failed to lower the moisture content to the extent originally anticipated, either more time could be allowed or more fixing agent could be used. If more time were allowed, the total mass of PCBs volatilized would increase. If more fixing agent were used, the total solids volume to disposed of would increase.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Fixation. Fixation would use existing equipment in an application similar to previous applications, but not yet established for these high-moisture-content sediments. Laboratory testing is now being conducted to verify that fixation can be accomplished with existing available materials and equipment. It is anticipated that fixation will prove to be a technically feasible and reliable means of controlling water loss. If fixation failed to prevent water loss, then solids would have to be dewatered mechanically as proposed for Alternative 3, or a waiver from that requirement of 40 CFR 761 would have to be obtained from the USEPA Regional Administrator.

Transportation. Transportation would be accomplished using dump trucks. Failure could occur by loss of material from the truck through leakage, spilling over the top, dusting, volatilization, or spills resulting from vehicle accidents.

The impact of leakage, dusting, and volatilization would be to disperse small amounts of PCBs all along the haul routes. These types of uncontrolled release could be minimized by the use of tailgate seals and covers.

The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more isolated points. The risk of spills over the top of the truck could be minimized by use of a cover. The risk of vehicle accidents is relatively small, but it could be compensated for by having a response plan and team ready during hauling.

Permit Requirements

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification of all USCOE permits
- Waukegan Port Authority dredging permit
- IEPA permit for construction of wastewater treatment facilities
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- IDOT (Division of Waterways) permit for work in public waterways
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and ILCC)
- USEPA toxic substances disposal approval

- IEPA approval if material is disposed in a currently non-PCB-approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

Alternative 2D: Dredge-Dewater in Barges-Fix-Dispose

Response Objectives

This alternative would remove all sediments from Slip No. 3 with PCB concentrations greater than 50 ppm. If a 95 percent removal efficiency were achieved, it would remove an estimated 290,000 lb of PCBs contained in approximately 10,900 yd^3 of sediments. This would remove about 93.5 percent of all the PCBs now found in the Slip No. 3 and Upper Harbor area (003).

Mathematical modeling conducted by HydroQual, Inc. (035), indicates that dredging of the harbor sediments to a level of 50 ppm PCB would reduce peak water column concentrations by approximately one order of magnitude (to less than 0.1 ppb) and fish body burdens to less than 5 ppm. Since this alternative would remove approximately 93.5 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor, results are expected to be similar to reductions predicted by the model. Removal would also significantly diminish the existing estimated volatilization rate of 12 to 40 lb/yr of PCBs that are released from Slip No. 3 into the local airshed by approximately an order of magnitude (007).

All former land and water uses would be able to resume after cleanup activities are completed. No restrictions to future uses would be expected.

Duration of Cleanup Activities

Dredging and related activities for Slip No. 3 would require about 2 months. An additional 2 months would be required for dredging and related activities in the localized area requiring dredging of deep contaminated sand and silt. If the water treatment plant were not protected against freezing weather, the dewatering barges would not be able to release slurry water to the plant during freezing conditions. Dredging would then have to occur during nonfreezing weather. Use of barges for dewatering may also be problematic during freezing periods, because of ice buildup and difficulty with sediment removal.

Solids removal to the batch plant would begin about 2 months after dredging activities are completed. Removal and fixation of the dewatered sediments would require 2 to 3 months.

Offsite transportation to the disposal site would be concurrent with the fixation process. Total project duration is estimated to be 9 months.

Impacts and Mitigation of Cleanup Activities

Dredging. Roiling of bottom sediments during dredging results in sediment suspension and dispersion. The use of a hydraulic dredge and the proper dredge head would minimize roiling and sediment dispersion. A sediment dispersal control system (double silt curtain or steel sheet piling) would also be employed to minimize migration of suspended PCBs out of the dredging area. To assist in controlling sediment dispersion, water would be continually pumped from inside the slip during construction to maintain net inflow at the slip mouth. This would tend to keep sediments from crossing the control barrier. The water could be treated by addition of polymer and/or activated carbon before the sediment barrier is removed.

A program would be established to monitor the effectiveness of the containment measures and to warn of the need for polymer addition or shutdown of dredging. A seiche warning arrangement with the National Weather Service would also be put in place so operations could be suspended if a seiche were imminent. The containment devices would be the most likely to fail during a seiche due to the forces created by a sudden difference in water level between the two sides of the sheet piling or double silt curtain.

A clamshell dredge may be required in the localized area of Slip No. 3 to remove the deep contaminated sediments (sand and silt) below the muck at the former OMC outfall. Spillage of 15 to 30 percent of the sediments in a clamshell bucket occurs while it is being raised. This spillage would create a high degree of sediment suspension that would increase the concentration of PCBs in solution. A sheet pile cofferdam would be employed to support the excavation sides and contain these dredging activities. The water would be treated by the addition of powdered activated carbon to remove dissolved PCBs before the cofferdam is removed. The water level inside the cofferdam would be lowered to create net inflow as an additional control measure.

The City of Waukegan maintains an emergency water intake in Waukegan Harbor. This water intake, while an integral part of the Waukegan Harbor system, is rarely used. Project activities would be expected to be completed while the intake was not in use. If, however, the intake was needed during project activities, a monitoring program, including sampling of raw and finished water, would be established during the project to ensure the safety of the supply. A contingency plan would also be established to stop project operations if any contamination entered the system.

Larsen Marine Services would be adversely affected by any dredging that inhibited or cut off access to its docks. These impacts would be short-term and could be minimized by scheduling dredging during periods that would cause the least impact on Larsen Marine Services.

Minimal volatilization would be expected to occur during dredging activities. Losses would be expected to be roughly 0.3 to 0.4 lb/day/acre from the exposed, agitated, and contaminated water area (030). Concentrations of less than 2 ug/m^3 would be expected to be present in the air as a result of dredging activities (007). By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m^3 in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m^3 in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

The proposed dredging would affect terrestrial biota. Populations of gulls and terns that currently reside and feed in the vicinity of the harbor would be disturbed by increased noise and activity levels and may move to another area along the shoreline of Lake Michigan during the times of the day when disturbances would occur. However, because none of these species breeds in the immediate vicinity of the harbor, no long-term displacement of populations is anticipated (048).

Some species of birds could come into contact with the contaminated sediments and water in the harbor and dewatering barges, particularly during non-working hours (gulls) and autumn migration periods (waterfowl and shorebirds) (048).

Changes in the harbor water column PCB concentrations and reduced PCB accumulations in fish would be the two principal long-term beneficial impacts of dredging.

Possible short-term adverse impacts of dredging would include the following:

- The area inside the sediment dispersal control device used to detain roiled sediments would become turbid during dredging and would very likely become anoxic in the pre-dawn hours following a day of dredging in organic "muck" sediments. Indications are that "disturbances" of polluted bottom sediments, especially if they have great quantities of reduced compounds dissolved in the interstitial waters, can elevate the expression of sediment oxygen demand by as much as one order of magnitude. Diurnal rhythms of respiration/photosynthesis in freshwater algae are such that the lowest oxygen levels occur in pre-dawn hours. Consequently, almost all respiring organisms inside the silt curtains would be driven out or may die during early morning hours after dredging (048).

- If dredging occurs during the fall and spring, there is a good chance that spawning fish may be present in the harbor during the dredging activities. Chinook making fall runs may be able to swim around or leap over the silt curtains into a highly PCB-laden body of water (048).

Dewatering. Under this alternative, barges would be used to dewater dredged sediments. The barges could be moored in the Upper Harbor during the dewatering process, then towed to shore for solids removal. No special lining would be necessary, since any water leakage would flow into the barges, and become mixed with the supernatant. Decant water would be pumped to the water treatment plant.

Some volatilization of PCBs would occur during dewatering. Volatilization would be minimized during initial placement of the dredged sediments by the decanting water layer. This would reduce the estimated volatilization rate from 2 lb PCBs per day (for exposed sediments with an average concentration of 1,000 ppm) to less than 1.0 lb PCBs per day from the less contaminated (100 ppm) decanting layer (007). Other measures that could be employed include: (1) placing the less contaminated sediments on top of the more contaminated sediments during dredging; (2) placing a layer of an organic material (e.g., digested activated sludge, manure) on top of the dewatering sediments upon completion of dredging; or (3) placing a synthetic liner on top of the water in the barges during and following dredging. These measures would be expected to keep PCB concentrations in the air above the barges at about 2 ug/m^3 (007).

Water Treatment. All PCB-contaminated water (supernatant from initial solids dewatering, leachate, rainwater, and monitoring well water collected from the lagoon) would be processed through a package water treatment plant. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct the water quality analyses. Effluent would be discharged to the harbor or to a sanitary sewer. Water discharged to the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Solids Removal, Fixation, and Disposal. Volatilization would be expected to occur during solids removal from the barges and truck loading for transport to the batch plant. The highest reported concentration in a Slip No. 3 sediment sample is about 500,000 ppm (008). The maximum predicted PCB concentration in the air from solids removal operations is predicted to be less than 200 ug/m³ for sediments with concentrations of 100,000 ppm PCBs (007). These values were extrapolated from data for sand assuming a 3.6-mph wind and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

Dewatered sediment would be fixed into a nonflowable form for offsite transport by truck. A sufficient amount of fixing agent would be used to prevent water loss, and covers may be required to prevent volatilization during transport. Rules and regulations controlling the transport of hazardous materials promulgated by the USDOT, USEPA, IDOT, IINR, and other applicable regulatory agencies would be complied with. These include cleanup, safety, and spill prevention and response measures.

Offsite disposal of fixed dredged sediments and volatilization material would require approximately 1,650 truck trips to the disposal site using a 10-yd³ capacity truck. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic, but some roadway congestion and roadway damage could occur (048). Some species of terrestrial animals could come into contact with contaminated materials if any loss occurs during transport, and the contamination could be passed into other terrestrial food chains (048).

Disposal of the fixed materials would be in a licensed chemical waste landfill, and would be in compliance with State and Federal standards for PCB waste disposal. PCB materials with concentrations greater than 50 ppm must be nonflowable if they are to be disposed of in a licensed chemical waste landfill (40 CFR 761). Solids dewatering and/or fixation must be complete enough to result in a nonflowable consistency after transport for final disposal.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, dredging, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Recreation. The noise and traffic congestion associated with construction activities could have short-term negative impacts on the public beach adjacent to the project area.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (See Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities and the dewatering barges. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Dredging. Both hydraulic and clamshell dredges have been widely used in the past for dredging. No new technologies are proposed to complete the dredging. Dredging technology is well developed, and the reliability of the equipment to remove sediments from the slip and transport them to the lagoons is high. If a stoppage of the hydraulic dredge occurs during dredging, it is expected to result in some temporary additional suspension of sediment in the water column because of interruption in hydraulic flow. Leakage or rupture of the hydraulic dredge discharge pipeline could disperse PCB-laden water and sediment over previously uncontaminated areas along the pipeline. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill. A contingency plan would be established for prompt cleanup. Leakage could either be eliminated by pipe joint tightening or be controlled by joint caulking, mats, collection containers, or similar means. The collected solids could be disposed of with the PCB-contaminated solids, and collected water could be taken to the water treatment plant.

Dewatering Barges. The technology for construction of barges and handling slurry materials is well developed and feasible. Conventionally available flat-deck barges could be used for dewatering. If a barge sank, PCB-contaminated water and sediment would flow back into the harbor. However, such an event is unlikely. If it occurred, additional dredging would be required to re-excavate the spilled sediment. Some loss of PCBs by way of the spilled supernatant would occur. It is estimated that this loss would be less than 0.1 lb of PCBs if one barge sank.

If detention in the barges failed to lower the moisture content to the extent originally anticipated, either more time could be allowed or more fixing agent could be used. If more time were allowed, the total mass of PCBs volatilized would increase. If more fixing agent were used, the total solids volume to be disposed of would increase.

Curing Cells. The technology for construction of the curing cells is well developed and feasible. There are no unusual construction details for the curing cell construction. Construction could be accomplished using conventionally available materials and equipment. The risk of failure would be low. If the upper clay liner failed, contaminated leachate could be collected by the underdrain system. If the lower clay liner also failed, contaminated soil would have to be excavated and disposed of with the other contaminated solids.

If an exterior curing cell dike failed while a cell was filled with incompletely cure fixed solids, PCB-contaminated water and sediment could flow over a small area, requiring cleanup operations and causing slightly increased volatilization. The technology for dike design is well understood, however, so the probability of dike failure would be extremely low.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Fixation. Fixation would use existing equipment in an application similar to previous applications, but not yet established for these high-moisture-content sediments. Laboratory testing is now being conducted to verify that fixation can be accomplished with existing available materials and equipment. It is anticipated that fixation will prove to be a technically feasible and reliable means of controlling water loss. If fixation failed to prevent water loss, then solids would have to be dewatered mechanically as proposed for Alternative 3, or a waiver from that requirement of 40 CFR 761 would have to be obtained from the Regional Administrator.

Transportation. Transportation would be accomplished using dump trucks. Failure could occur by loss of material from the truck through leakage, spilling over the top, dusting, volatilization, or spills resulting from vehicle accidents.

The impact of leakage, dusting, and volatilization would be to disperse small amounts of PCBs all along the haul routes. These types of uncontrolled release could be minimized by the use of tailgate seals and covers.

The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more isolated points. The risk of spills over the top of the truck could be minimized by use of a cover. The risk of vehicle accidents is relatively small, but it could be compensated for by having a response plan and team ready during hauling.

Permit Requirements

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- Waukegan Port Authority dredging permit

- IEPA permit for construction of wastewater treatment facilities
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- IDOT (Division of Waterways) permit for work in public waterways
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and ILCC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

Alternative 3: Dredge-Dewater in Lagoon-Dispose

Response Objectives

This alternative would remove all sediments from Slip No. 3 with concentrations of PCBs greater than 50 ppm. If a 95 percent removal efficiency were achieved, it would remove an estimated 290,000 lb of PCBs contained in approximately 10,900 yd^3 of sediments. This would remove about 93.5 percent of all the PCBs now found in the Slip No. 3 and Upper Harbor area (003).

Mathematical modeling conducted by HydroQual, Inc. (035), indicates that dredging of the harbor sediments to a level of 50 ppm PCB would reduce peak water column concentrations by approximately one order of magnitude (to less than 0.1 ppb) and fish body burdens to less than 5 ppm. Since this alternative would remove approximately 93.5 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor, results are expected to be similar to reductions predicted by the model. Removal would also significantly diminish the existing estimated volatilization rate of 12 to 40 lb/yr of PCBs released from the harbor into the local airshed by approximately an order of magnitude (007).

All former land and water uses would be able to resume after cleanup activities are completed. No restrictions to future uses would be expected.

Duration of Cleanup Activities

Dredging and related activities for Slip No. 3 would require about 2 months. An additional 2 months would be required for dredging and related activities in the localized area requiring dredging of deep contaminated sand and silt. If the water treatment plant were not protected against freezing weather, the dewatering lagoon would not be able to release slurry water to the plant during freezing conditions. Dredging would then have to occur during nonfreezing weather.

Because dredged solids would not be fixed, they would have to be dewatered in the lagoon for an extended time to reach an adequate nonflowable consistency for disposal. Even with the employment of additional mechanical dewatering, retention time is expected to be from 1 to 2 years.

Offsite transportation to the disposal site would begin approximately 3 to 4 months after completion of dredging. Transportation would continue intermittently until project completion. Total project duration is estimated to be 3 years.

Impacts and Mitigation of Cleanup Activities

Dredging. Roiling of bottom sediments during dredging results in sediment suspension and dispersion. The use of a hydraulic dredge and the proper dredge head would minimize roiling and sediment dispersion. A sediment dispersal control system (double silt curtain or steel sheet piling) would also be employed to minimize migration of suspended PCBs out of the dredging area. To assist in controlling sediment dispersion, water would be continually pumped from inside the Upper Harbor during construction to maintain net inflow at the Upper Harbor mouth. This would tend to keep sediments from crossing the control barrier. The water could be treated by addition of polymer and/or activated carbon before the sediment barrier is removed.

A program would be established to monitor the effectiveness of the containment measures and to warn of the need for polymer addition or shutdown of dredging. A seiche warning arrangement with the National Weather Service would also be put in place so operations could be suspended if a seiche were imminent. The containment devices would be most likely to fail during a seiche due to the forces created by a sudden difference in water level between the two sides of the sheet piling or double silt curtain.

A clamshell dredge may be required in the localized area of Slip No. 3 to remove the deep contaminated sediments (sand and silt) below the muck at the former OMC outfall. Spillage of 15 to 30 percent of the sediments in a clamshell bucket occurs while it is being raised. This spillage would create a high degree of sediment suspension that would increase the concentration of PCBs in solution. A sheet pile cofferdam would be employed to support the excavation sides and contain these dredging activities. The water would be treated by the addition of powdered activated carbon to remove dissolved PCBs before the cofferdam sediment barrier was removed. The water level inside the cofferdam would be lowered to create net inflow as an additional control measure.

The City of Waukegan maintains an emergency water intake in Waukegan Harbor. This water intake, while an integral part of the Waukegan Harbor system, is rarely used. Project activities would be expected to be completed while the intake was not in use. If, however, the intake was needed during project activities, a monitoring program, including sampling of raw and finished water, would be established during the project to ensure the safety of the supply. A contingency plan would also be established to stop project operations if any contamination entered the system.

Larsen Marine Services would be adversely affected by any dredging that inhibited or cut off access to its docks. These impacts would be short-term and could be minimized by scheduling dredging during periods that would cause the least impact on Larsen Marine Services.

Minimal volatilization would be expected to occur during dredging activities. Losses would be expected to be roughly 0.3 to 0.4 lb/day/acre from the exposed, agitated, and contaminated water area (030). Concentrations of less than 2 ug/m^3 would be expected to be present in the air as a result of dredging activites (007). By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m^3 in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m^3 in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

The proposed dredging would affect terrestrial biota. Populations of gulls and terns that currently reside and feed in the vicinity of the harbor would be disturbed by increased noise and activity levels and may move to another area along the shoreline of Lake Michigan during the times of the day when disturbances would occur. However, because none of these species breeds in the immediate vicinity of the harbor, no long-term displacement of populations is anticipated (048).

Some species of birds or other animals could come into contact with the contaminated sediments and water in the harbor and dewatering lagoon, particularly during non-working hours (gulls) and autumn migration periods (waterfowl and shorebirds) (048).

Changes in the harbor water column PCB concentrations and reduced PCB accumulations in fish would be the two principal long-term beneficial impacts of dredging.

Possible short-term adverse impacts of dredging would include the following:

- The area inside the sediment dispersal control device used to detain roiled sediments would become turbid during dredging and would very likely become anoxic in the pre-dawn hours following a day of dredging in organic "muck" sediments. Indications are that "disturbances" of polluted bottom sediments, especially if they have great quantities of reduced compounds dissolved in the interstitial waters, can elevate the expression of sediment oxygen demand by as much as one order of magnitude. Diurnal rhythms of respiration/photosynthesis in freshwater algae are such that the lowest oxygen levels occur in pre-dawn hours. Consequently, almost all respiring organisms inside the silt curtains would be driven out or may die during early morning hours after dredging (048).

- If dredging occurs during the fall and spring, there is a good chance that spawning fish may be present in the harbor during the dredging activities. Chinook making fall runs may be able to swim around or leap over the silt curtains into a highly PCB-laden body of water (048).

Dewatering. Construction of a dewatering lagoon and treatment facilities on OMC property or another nearby site would remove this land from other uses for the duration of the project.

The lagoon would be constructed with impermeable clay liners and a leachate collection system. The groundwater beneath the lagoon would be monitored by test wells to detect leakage from the lagoon.

Under this alternative, volatilization would be significantly increased during retention of the dredged materials in the lagoon because mechanical dewatering would be employed. The RUC system (or other channelization techniques) would be used to channel the sediments for drainage of water to expose them to air for evaporation and drying. After the top layer was dry, it would be removed and the process would be repeated. This would result in substantially more volatilization of PCBs to the atmosphere than for Alternatives 2B and 2D, since evaporation is a necessary part of the dewatering process. The highest reported concentration in a Slip No. 3 sediment sample is about 500,000 ppm (008, 016). The predicted PCB concentration in the air from volatilization above these sediments would be less than 200 ug/m³ for sediments with concentrations of 100,000 ppm PCBs. The volatilization rate is predicted to be less than 163,000 ug/m²/hr or 63 lb/day. Typical PCB concentrations range from about 500 to 5,000 ppm PCB. Predicted average concentrations in the air from volatilization would be less than 6.6 ug/m³, assuming a typical PCB concentration of 1,000 ppm. The average volatilization rate from these sediments is expected to be less than 5,375 ug/m²/hr or 2 lb/day PCB. These values are extrapolated from data for sand, assuming a 3.6-mph wind and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

Because this alternative would require more time for solids dewatering, it would restrict land uses on the OMC property or another nearby site used for the lagoon for a longer period than Alternative 2B. It would, however, involve less total property use, since it would not require land for the fixation process.

Water Treatment. All PCB-contaminated water (supernatant from initial solids dewatering, leachate, rainwater, and monitoring well water collected from the lagoon) would be processed through a package water treatment plant. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct water quality analyses. Effluent would be discharged to the harbor or to a sanitary sewer. Water discharged to the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Solids Removal and Disposal. Volatilization would be expected to occur during solids removal from the lagoon and truck loading for offsite transport. The highest reported concentration in a Slip No. 3 sediment sample is about 500,000 ppm (008, 016). The predicted PCB concentration in the air from volatilization above these sediments would be less than 200 ug/m³ for sediments with concentrations of 100,000 ppm PCBs. The volatilization rate is predicted to be less than 163,000 ug/m²/hr or 63 lb/ day. Typical PCB concentrations range from about 500 to 5,000 ppm PCB. Predicted average concentrations in the air from volatilization would be less than 6.6 ug/m^3, assuming a typical PCB concentration of 1,000 ppm. The average volatilization rate from these sediments is expected to be less than 5,375 $ug/m^2/hr$ or 2 lb/day PCB. These values are extrapolated from data for sand, assuming a 3.5-mph wind and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007). Since the sediments would be dry, PCB-laden dust particles may be dispersed in the air by excavation activities. This may cause ambient air concentrations to exceed 1,000 ug/m^3.

Additional precautions would be required during offsite transportation of the non-fixed materials. Trucks would have to employ a liner (such as heavy-duty plastic sheeting) to prevent leakage or spillage. Cover or closure of the trucks would be required to prevent spillage and volatilization during transport. Rules and regulations controlling the transport of toxic materials promulgated by the USDOT, USEPA, IDOT, IINR, and other applicable regulatory agencies would be complied with. These include cleanup, safety, and spill prevention and response measures.

Offsite disposal of fixed dredged sediments and liner material would require approximately 16,700 truck trips to the disposal site using a 10-yd^3 capacity truck. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic, but some roadway congestion and roadway damage could occur (048). Some species of terrestrial animals could come into contact with contaminated materials if any loss occurs during transport, and the contamination could be passed into other terrestrial food chains (048).

Disposal of the materials would be in a licensed chemical waste landfill, and would be in compliance with State and Federal standards for PCB waste disposal. PCB materials with concentrations greater than 50 ppm must be nonflowable if they are to be disposed of in a chemical waste landfill (40 CFR 761). Solids dewatering must be complete enough to result in a nonflowable consistency after transport to the final disposal site. If a nonflowable consistency cannot be obtained, fixation will be required.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, dredging, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Recreation. The noise and traffic congestion associated with construction activities could have short-term negative impacts on the public beach adjacent to the project area.

The City of Waukegan uses the site proposed for the dewatering lagoon as a parking area for its public festivals. This alternative would preclude this use for the project duration. The city would have to arrange other transportation means (such as a shuttle system between the downtown area and the beach) because no alternative parking facilities are available.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (see Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities and the holding lagoon. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Dredging. Both hydraulic and clamshell dredges have been widely used in the past for dredging. No new technologies are proposed to complete the dredging. Dredging technology is well developed, and the reliability of the equipment to remove sediments from the slip and transport them to the lagoons is high. If a stoppage of the hydraulic dredge occurs during dredging, it is expected to result in some temporary additional suspension of sediment in the water column because of interruption in hydraulic flow. Leakage or rupture of the hydraulic dredge discharge pipeline could disperse PCB-laden water and sediment over previously uncontaminated areas along the pipeline. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill. A contingency plan would be established for prompt cleanup. Leakage could either be eliminated by pipe joint tightening or be controlled by joint caulking, mats, collection containers, or similar means. The collected solids could be disposed of with the PCB-contaminated solids, and collected water could be taken to the water treatment plant.

Dewatering Lagoon. The technology for construction of lined lagoons is well developed and feasible. There are no unusual construction details for the lagoon construction. Construction could be accomplished using conventionally available materials and equipment. The risk of failure would be low. of the upper clay liner failed, contaminated leachate could be collected by the underdrain system. If the lower clay liner also failed, contaminated soil would have to be excavated and disposed of with the other contaminated solids.

If an exterior lagoon failed, PCB-contaminated water and sediment could flow over a very large area, requiring substantial cleanup operations and causing greatly increased volatilization. The technology for dike design is well understood, however, so the probability of dike failure would be extremely low.

If detention in the lagoon failed to lower the moisture content to the extent originally anticipated, more time would have to be allowed. If more time were allowed, the total mass of PCBs volatilized would increase.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Transportation. Transportation would be accomplished using dump trucks. Failure could occur by loss of material from the truck through leakage, spilling over the top, dusting, volatilization, or spills resulting from vehicle accidents.

The impact of leakage, dusting, and volatilization would be to disperse small amounts of PCBs all along the haul routes.

These types of uncontrolled release could be minimized by the use of tailgate seals and covers.

The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more isolated points. The risk of spills over the top of the truck could be minimized by use of a cover. The risk of vehicle accidents is relatively small, but it could be compensated for by having a response plan and team ready during hauling.

Permit Requirements

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- Waukegan Port Authority dredging permit
- IEPA permit for construction of wastewater treatment facilities
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to the sanitary sewer
- IDOT (Division of Waterways) permit for work in public waterways
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and ICC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

UPPER HARBOR

Alternative 2B: Dredge-Dewater in Lagoon-Fix-Dispose

Response Objective

This alternative would remove all sediments from the Upper Harbor with PCB concentrations greater than 50 ppm. If a 95 percent removal efficiency were achieved, it would remove an estimated 4,800 lb of PCBs contained in approximately 35,700 yd^3 of sediments. This would remove about 1.5 percent of all the PCBs now found in the Slip No. 3 and Upper Harbor area (003).

Assuming that exposed sediment PCB concentrations are reduced below 50 ppm in the harbor, peak water column concentrations of PCBs are expected to be reduced to 0.1 ppb and fish body burdens are expected to decline to less than 5 ppm (035). (If the Upper Harbor were remedied without remedying Slip No. 3, this would not be true.) Removal would also diminish the existing estimated volatilization rate of 12 to 40 lb/yr of PCBs that are released from the harbor into the local airshed by approximately an order of magnitude (007).

All former land and water uses would be able to resume after cleanup activities are completed. No restrictions to future uses would be expected.

Duration of Cleanup Activities

Dredging and related activities of the Upper Harbor would require about 3 months. (This would be in addition to the 4 months required for the dredging and related activities of Slip No. 3.) If the water treatment plant were not protected against freezing weather, the dewatering lagoon would not be able to release slurry water to the plant during freezing conditions. Dredging would then have to occur during non-freezing weather.

Solids removal to the batch plant would begin about 2 months after dredging activities are completed. Removal and fixation of the dewatered sediments would require 2 to 3 months. Offsite transportation to the disposal site would be concurrent with the fixation process. Total project duration is estimated to be 13 months.

Impacts and Mitigation of Cleanup Activities

Dredging. Roiling of bottom sediments during dredging results in sediment suspension and dispersion. The use of a hydraulic dredge and the proper dredge head would minimize roiling and sediment dispersion. A sediment dispersal control system (double silt curtain or steel sheet piling) would also be employed to minimize migration of suspended PCBs out of the dredging area. To assist in controlling sediment dispersion, water would be continually pumped from inside the Upper Harbor during construction to maintain net inflow at the Upper Harbor mouth. This would tend to keep sediments from crossing the control barrier. The water could be treated by addition of polymer and/or activated carbon before the sediment barrier is removed.

A program would be established to monitor the effectiveness of the containment measures and to warn of the need for polymer addition or shutdown of dredging. A seiche warning arrangement with the National Weather Service would also be put in place so operations could be suspended if a seiche were imminent. The containment devices would be the most likely to fail during a seiche due to the forces created by a sudden difference in water level between the two sides of the sheet piling or double silt curtain.

The City of Waukegan maintains an emergency water intake in Waukegan Harbor. This water intake, while an integral part of the Waukegan Harbor system, is rarely used. Project activities would be expected to be completed while the intake was not in use. If, however, the intake was needed during project activities, a monitoring program, including sampling of raw and finished water, would be established during the project to ensure the safety of the supply. A contingency plan would also be established to stop project operations if any contamination entered the system.

Larsen Marine Services would be adversely affected by any dredging that inhibited or cut off access to its docks. These impacts would be short-term and could be minimized by scheduling dredging during periods that would cause the least impact on Larsen Marine Services.

Minimal volatilization would be expected to occur during dredging activities. Losses would be expected to be roughly 0.3 to 0.4 lb/day/acre from the exposed, agitated, and contaminated water area (030). Concentrations of less than 2 ug/m^3 would be expected to be present in the air as a result of dredging activities (007). By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m^3 in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m^3 in the air during an 8-hour period (007). (See <u>Health and Safety Requirements</u>, later in this section.)

The proposed dredging would affect terrestrial biota. Populations of gulls and terns that currently reside and feed in the vicinity of the harbor would be disturbed by increased noise and activity levels and may move to another area along the shoreline of Lake Michigan during the times of the day when disturbances would occur. However, because none of these species breeds in the immediate vicinity of the harbor, no long-term displacement of populations is anticipated (048).

Some species of birds or other animals could come into contact with the contaminated sediments and water in the harbor and dewatering lagoon, particularly during non-working hours (gulls) and autumn migration periods (waterfowl and shorebirds) (048).

Changes in the harbor water column PCB concentrations and reduced PCB accumulations in fish would be the two principal long-term beneficial impacts of dredging.

Possible short-term adverse impacts of dredging would include the following:

- The area inside the sediment dispersal control device used to detain roiled sediments would become turbid during dredging and would very likely become anoxic in the pre-dawn hours following a day of dredging in organic "muck" sediments. Indications are that "disturbances" of polluted bottom sediments, especially if they have great quantities of reduced compounds dissolved in the interstitial waters, can elevate the expression of sediment oxygen demand by as much as one order of magnitude. Diurnal rhythms of respiration/photosynthesis in freshwater algae are such that the lowest oxygen levels occur in pre-dawn hours. Consequently, almost all respiring organisms inside the silt curtains would be driven out or may die during early morning hours after dredging (048).

- If dredging occurs during the fall and spring, there is a good chance that spawning fish may be present in the harbor during the dredging activities. Chinook making fall runs may be able to swim around or leap over the silt curtains into a highly PCB-laden body of water (048).

Dewatering. Construction of a dewatering lagoon and treatment facilities on OMC property or another nearby site would remove this land from other uses for the duration of the project.

The lagoon would be constructed with impermeable clay liners and a leachate collection system. The groundwater beneath the lagoon would be monitored by test wells to detect leakage from the lagoon.

Some volatilization of PCBs would occur during dewatering. Volatilization would be minimized during initial placement of the dredged sediments by the decanting water layer. This might reduce the estimated volatilization rate from 1.4 lb PCBs per day (for exposed sediments with a typical concentration of 100 ppm) to less than 1 lb PCBs per day from less contaminated decanting water layer (007, 030). Other measures that could be employed include: (1) placing the less contaminated sediments on top of the more contaminated sediments during dredging; (2) placing a layer of an organic material (e.g., digested activated sludge, manure) on top of the dewatering sediments upon completion of dredging; or (3) placing a synthetic liner on top of the water in the lagoon during and following dredging. These measures would be expected to keep PCB concentrations in the air above the lagoon at about 2 ug/m³ (007).

Water Treatment. All PCB-contaminated water (supernatant from initial solids dewatering, leachate, rainwater, and monitoring well water collected from the lagoon) would be processed through a package water treatment plant. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct the water quality analyses. Effluent would be discharged to the harbor or to a sanitary sewer. Water discharged to the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Solids Removal, Fixation, and Disposal. Volatilization would be expected to occur during solids removal from the lagoon and truck loading for transport to the batch plant. The highest reported concentration in Upper Harbor sediments is about 500 ppm PCBs. The maximum predicted PCB concentration in the air from solids removal operations is predicted to be less than 6.6 ug/m³. Typical PCB concentrations range from about 50 to 500 ppm PCBs. Average PCB concentrations in the air are expected to be less than 1.0 ug/m³ for sediments with concentrations of 100 ppm PCBs (007). These values were extrapolated from data for sand, assuming 3.6-mph wind and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

Dewatered sediment would be fixed into a nonflowable form for offsite transport by truck. A sufficient amount of fixing agent would be used to prevent water loss, and covers may be required to prevent volatilization during transport. Rules and regulations controlling the transport of hazardous materials promulgated by the USDOT, USEPA, IDOT, IINR, and other applicable regulatory agencies would be complied with. These include cleanup, safety, and spill prevention and response measures.

Offsite disposal of fixed dredged sediments, volatilization material, and liner material would require approximately 8,220 truck trips to the disposal site using a 10-yd^3 capacity truck. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic, but some roadway congestion and roadway damage could occur (048). Some species of terrestrial animals could come into contact with contaminated materials if any loss occurs during transport, and the contamination could be passed into other terrestrial food chains (048).

Disposal of the materials would be in a licensed chemical waste landfill, and would be in compliance with State and Federal standards for PCB waste disposal. PCB materials with concentrations greater than 50 ppm must be nonflowable if they are to be disposed of in a chemical waste landfill (40 CFR 761). Solids dewatering and/or fixation must be complete enough to result in a nonflowable consistency after transport for final disposal.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, dredging, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Recreation. The noise and traffic congestion associated with construction activities could have short-term negative impacts on the public beach adjacent to the project area.

The City of Waukegan uses the site proposed for the dewatering lagoon as a parking area for its public festivals. This alternative would preclude this use for the project duration. The city would have to arrange other transportation means (such as a shuttle system between the downtown area and the beach) because no alternative parking facilities are available.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (see Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities and the dewatering lagoons. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Dredging. Hydraulic dredges have been widely used in the past for dredging. No new technologies are proposed to complete the dredging. Dredging technology is well developed, and the reliability of the equipment to remove sediments from the Upper Harbor and transport them to the lagoons is high. If a stoppage of the hydraulic dredge occurs during dredging, it is expected to result in some temporary additional suspension of sediment in the water column because of interruption in hydraulic flow. Leakage or rupture of the hydraulic dredge discharge pipeline could disperse PCB-laden water and sediment over previously uncontaminated areas along the pipeline. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill. A contingency plan would be established for prompt cleanup. Leakage could either be eliminated by pipe joint tightening or be controlled by joint caulking, mats, collection containers, or similar means. The collected solids could be disposed of with the PCB-contaminated solids, and collected water could be taken to the water treatment plant.

Dewatering Lagoon and Curing Cells. The technology for construction of lined lagoons is well developed and feasible. There are no unusual construction details for the lagoon construction. Construction could be accomplished using conventionally available materials and equipment. The risk of failure would be low. If the upper clay liner failed, contaminated leachate could be collected by the underdrain system.

If the lower clay liner also failed, contaminated soil would have to be excavated and disposed of with the other contaminated solids.

If an exterior lagoon dike failed, PCB-contaminated water and sediment could flow over a large area, requiring substantial cleanup operations and causing greatly increased volatilization. The technology for dike design is well understood, however, so the probability of dike failure would be extremely low.

If an exterior curing cell dike failed while a cell was filled with incompletely cured fixed solids, PCB-contaminated water and sediment could flow over a small area, requiring cleanup operations and causing slightly increased volatilization. The technology for dike design is well understood, however, so the probability of dike failure would be extremely low.

If detention in the lagoon failed to lower the moisture content to the extent originally anticipated, either more time could be allowed or more fixing agent could be used. If more time were allowed, the total mass of PCBs volatilized would increase. If more fixing agent were used, the total solids volume to dispose of would increase.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Fixation. Fixation would use existing equipment in an application similar to previous applications, but not yet established for these high-moisture-content sediments. Laboratory testing is now being conducted to verify that fixation can be accomplished with existing available materials and equipment. It is anticipated that fixation will prove to be a technically feasible and reliable means of controlling water loss. If fixation failed to prevent water loss, then solids would have to be dewatered mechanically as proposed for Alternative 3, or a waiver from that requirement of 40 CFR 761 would have to be obtained from the USEPA Regional Administrator.

Transportation. Transportation would be accomplished using dump trucks. Failure could occur by loss of material from the truck through leakage, spilling over the top, dusting, volatilization, or spills resulting from vehicle accidents.

The impact of leakage, dusting, and volatilization would be to disperse small amounts of PCBs all along the haul routes. These types of uncontrolled release could be minimized by the use of tailgate seals and covers.

The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more isolated points. The risk of spills over the top of the truck could be minimized by use of a cover. The risk of vehicle accidents is relatively small, but it could be compensated for by having a response plan and team ready during hauling.

Permit Requirements

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- Waukegan Port Authority dredging permit
- IEPA permit for construction of wastewater treatment facilities
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- IDOT (Division of Waterways) permit for work in public waterways
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and IlCC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

Alternative 3: Dredge-Dewater in Lagoon-Dispose

Response Objectives

This alternative would remove all sediments from the Upper Harbor with PCB concentrations greater than 50 ppm. If a 95 percent removal efficiency were achieved, it would remove an estimated 4,800 lb of PCBs contained in approximately 35,700 yd^3 of sediments. This would remove about 1.5 percent of all the PCBs now found in the Slip No. 3 and Upper Harbor area (003).

Assuming that exposed sediment PCB concentrations are reduced below 50 ppm in the harbor, peak water column concentrations of PCBs are expected to be reduced to 0.1 ppb and fish body burdens are expected to decline to less than 5 ppm (035). (If the Upper Harbor were remedied without remedying Slip No. 3, this would not be true.) Removal would also diminish the existing estimated volatilization rate of 12 to 40 lb/yr of PCBs that are released from the harbor into the local airshed by approximately an order of magnitude (007).

All former land and water uses would be able to resume after cleanup activities are completed. No restrictions to future uses would be expected.

Duration of Cleanup Activities

Dredging and related activities for the Upper Harbor would require about 3 months. (This is in addition to the 4 months required for the dredging and related activities of Slip No. 3.) If the water treatment plant were not protected against freezing weather, the dewatering lagoon could not release slurry water to the plant during freezing conditions. Dredging would then have to occur during nonfreezing weather.

Because dredged solids would not be fixed, they would have to be dewatered in the lagoon for an extended time to reach an adequate nonflowable consistency for disposal. Even with the employment of additional mechanical dewatering (RUC), retention time is expected to be from 1 to 2 years.

Offsite transportation to the disposal site would begin approximately 3 to 4 months after completion of dredging. Transportation would continue intermittently until project completion. Total project duration is estimated to be 3 years.

Impacts and Mitigation of Cleanup Activities

Dredging. Roiling of bottom sediments during dredging results in sediment suspension and dispersion. The use of a hydraulic dredge and the proper dredge head would minimize roiling and sediment dispersion. A sediment dispersal control system (double silt curtain or steel sheet piling) would also be employed to minimize migration of suspended PCBs out of the dredging area. To assist in controlling sediment dispersion, water would be continually pumped from inside the Upper Harbor during construction to maintain net inflow at the Upper Harbor mouth. This would tend to keep sediments from crossing the control barrier. The water could be treated by addition of polymer and/or activated carbon before the sediment barrier is removed.

A program would be established to monitor the effectiveness of the containment measures and to warn of the need for polymer addition or shutdown of dredging. A seiche warning arrangement with the National Weather Service would also be put in place so operations could be suspended if a seiche were imminent. The containment devices would be the most likely to fail during a seiche due to the forces created by a sudden difference in water level between the two sides of the sheet piling or double silt curtain.

The City of Waukegan maintains an emergency water intake in Waukegan Harbor. This water intake, while an integral part of the Waukegan Harbor system, is rarely used. Project activities would be expected to be completed while the intake was not in use. If, however, the intake was needed during project activities, a monitoring program, including sampling of raw and finished water, would be established during the project to ensure the safety of the supply. A contingency plan would also be established to stop project operations if any contamination entered the system.

Larsen Marine Services would be adversely affected by any dredging that inhibited or cut off access to its docks. These impacts would be short-term and could be minimized by scheduling dredging during periods that would cause the least impact on Larsen Marine Services.

Minimal volatilization would be expected to occur during dredging activities. Losses would be expected to be roughly 0.3 to 0.4 lb/day/acre from the exposed, agitated, and contaminated water area (030). Concentrations of less than 2 ug/m^3 would be expected to be present in the air as a result of dredging activities (007). By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m^3 in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m^3 in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

The proposed dredging would affect terrestrial biota. Populations of gulls and terns that currently reside and feed in the vicinity of the harbor would be disturbed by increased noise and activity levels and may move to another area along the shoreline of Lake Michigan during the times of the day when disturbances would occur. However, because none of these species breeds in the immediate vicinity of the harbor, no long-term displacement of populations is anticipated (048).

Some species of birds or other animals could come into contact with the contaminated sediments and water in the harbor and dewatering lagoon, particularly during non-working hours (gulls) and autumn migration periods (waterfowl and shorebirds) (048).

Changes in the harbor water column PCB concentrations and reduced PCB accumulations in fish would be the two principal long-term beneficial impacts of dredging.

Possible short-term adverse impacts of dredging would include the following:

- The area inside the sediment dispersal control device used to detain roiled sediments would become turbid during dredging and would very likely become anoxic in the pre-dawn hours following a day of dredging in organic "muck" sediments. Indications are that "disturbances" of polluted bottom sediments, especially if they have great quantities of reduced compounds dissolved in the interstitial waters, can elevate the expression of sediment oxygen demand by as much as one order of magnitude. Diurnal rhythms of respiration/photosynthesis in freshwater algae are such that the lowest oxygen levels occur in pre-dawn hours. Consequently, almost all respiring organisms inside the silt curtains would be driven out or may die during early morning hours after dredging (048).

- If dredging occurs during the fall and spring, there is a good chance that spawning fish may be present in the harbor during the dredging activities. Chinook making fall runs may be able to swim around or leap over the silt curtains into a highly PCB-laden body of water (048).

Dewatering. Construction of a dewatering lagoon and treatment facilities on OMC property or another nearby site would remove this land from other uses for the duration of the project.

The lagoon would be constructed with impermeable clay liners and a leachate collection system. The groundwater beneath the lagoon would be monitored by test wells to detect leakage from the lagoon.

Under this alternative, volatilization would be significantly increased during retention of the dredged materials in the lagoon because mechanical dewatering would be employed. The RUC system (or other channelization techniques) would be used to channel the sediments for drainage of water to expose them to air for evaporation and drying. After the top layer was dried, it would be removed and the process repeated. This would result in substantially more volatilization of PCBs to the atmosphere than for Alternative 2B, since evaporation is a necessary part of the dewatering process. The highest reported concentration in Upper Harbor sediments is about 500 ppm PCB. The maximum predicted PCB concentration in air above these sediments would be less than 6.6 ug/m^3, well below 1,000 ug/m^3, the OSHA standard. The volatilization rate is predicted to be less than 5,375 $ug/m^2/hr$. Typical concentrations are about 50 to 500 ppm. Predicted average PCB concentrations in the air would be less than 1.0 ug/m^3. The average volatilization rate is expected to be about 725 $ug/m^2/hr$ or 1.4 lb/day of PCBs. These values were extrapolated from data for sand, assuming a wind speed of 3.6-mph and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

Because this alternative would require more time for solids dewatering, it would restrict land uses on the OMC property or other nearby site used for the lagoon for a longer period than Alternative 2B. It would, however, involve less total property use, since it would not require land for the fixation process.

Water Treatment. All PCB-contaminated water (supernatant from initial solids dewatering, leachate, rainwater, and monitoring well water collected from the lagoon) would be processed through a package water treatment plant. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct water quality analyses. Effluent would be discharged to the harbor or to a sanitary sewer. Water discharged to the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Solids Removal and Disposal. Volatilization would be expected to occur during solids removal from the lagoon and truck loading for offsite transport. The highest reported concentration in Upper Harbor sediments is about 500 ppm PCB. The maximum predicted PCB concentration in air above these sediments would be less than 6.6 ug/m^3, well below 1,000 ug/m^3, the OSHA standard. The volatilization rate is predicted to be less than 5,375 ug/m^2/hr. Typical concentrations are about 50 to 500 ppm. Predicted average PCB concentrations in the air would be less than 1.0 ug/m^3 for sediments with concentrations of 100 ppm PCBs. The average volatilization rate is expected to be about 725 ug/m^2/hr or 1.4 lb/day of PCBs. These values were extrapolated from data for sand, assuming a wind speed of 3.6-mph and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007). Increased concentrations of PCBs may result in the air from PCB-contaminated dust produced by excavation activities, since these solids will be dry and dusty.

Additional precautions would be required during offsite transportation of the non-fixed materials. Trucks would have to employ a liner (such as heavy-duty plastic sheeting) to prevent leakage or spillage. Cover or closure of the trucks would be required to prevent spillage and volatilization during transport. Rules and regulations controlling the transport of toxic materials promulgated by the USDOT, USEPA, IDOT, IINR, and other applicable regulatory agencies would be complied with. These include cleanup, safety, and spill prevention and response measures.

Offsite disposal of fixed dredged sediments and liner material would require approximately 6,110 truck trips to the disposal site using a 10-yd^3 capacity truck. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic, but some roadway congestion and roadway damage could occur (048). Some species of terrestrial animals could come into contact with contaminated materials if any loss occurs during transport, and the contamination could be passed into other terrestrial food chains (048).

Disposal of the materials would be in a licensed chemical waste landfill, and would be in compliance with State and Federal standards for PCB waste disposal. PCB materials with concentrations greater than 50 ppm must be nonflowable if they are to be disposed of in a chemical waste landfill (40 CFR 761). Solids dewatering must be complete enough to result in a nonflowable consistency after transport to the final disposal site. If a nonflowable consistency cannot be obtained, fixation will be required.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, dredging, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Recreation. The noise and traffic congestion associated with construction activities could have short-term negative impacts on the public beach adjacent to the project area.

The City of Waukegan uses the site proposed for the dewatering lagoon as a parking area for its public festivals. This alternative would preclude this use for the project duration. The city would have to arrange other transportation means (such as a shuttle system between the downtown area and the beach) because no alternative parking facilities are available.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (see Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities and the holding lagoon. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Dredging. Hydraulic dredges have been widely used in the past for dredging. No new technologies are proposed to complete the dredging. Dredging technology is well developed, and the reliability of the equipment to remove sediments from the Upper Harbor and transport them to the lagoons is high. If a stoppage of the hydraulic dredge occurs during dredging, it is expected to result in some temporary additional suspension of sediment in the water column because of interruption in hydraulic flow. Leakage or rupture of the hydraulic dredge discharge pipeline could disperse PCB-laden water and sediment over previously uncontaminated areas along the pipeline. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill. A contingency plan would be established for prompt cleanup. Leakage could either be eliminated by pipe joint tightening or be controlled by joint caulking, mats, collection containers, or similar means. The collected solids could be disposed of with the PCB-contaminated solids, and collected water could be taken to the water treatment plant.

Dewatering Lagoon. The technology for construction of lined lagoons is well developed and feasible. There are no unusual construction details for the lagoon construction. Construction could be accomplished using conventionally available materials and equipment. The risk of failure would be low. If the upper clay liner failed, contaminated leachate could be collected by the underdrain system. If the lower clay liner also failed, contaminated soil would have to be excavated and disposed of with the other contaminated solids.

If an exterior lagoon failed, PCB-contaminated water and sediment could flow over a very large area, requiring substantial cleanup operations and causing greatly increased volatilization. The technology for dike design is well understood, however, so the probability of dike failure would be extremely low.

If detention in the lagoon failed to lower the moisture content to the extent originally anticipated, more time would have to be allowed. If more time were allowed, the total mass of PCBs volatilized would increase.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Transportation. Transportation would be accomplished using dump trucks. Failure could occur by loss of material from the truck through leakage, spilling over the top, dusting, volatilization, or spills resulting from vehicle accidents.

The impact of leakage, dusting, and volatilization would be to disperse small amounts of PCBs all along the haul routes. These types of uncontrolled release could be minimized by the use of tailgate seals and covers.

The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more isolated points. The risk of spills over the top of the truck could be minimized by use of a cover. The risk of vehicle accidents is relatively small, but it could be compensated for by having a response plan and team ready during hauling.

Permit Requirements

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterway) permit
- IEPA water quality certification on all USCOE permits
- Waukegan Port Authority dredging permit
- IEPA permit for construction of wastewater treatment facilities
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- IDOT (Division of Waterways) permit for work in public waterways
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and ILCC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

SLIP NO. 3 AND UPPER HARBOR

Alternative 6A: Contain-Dredge-Cap

Response Objectives

Under this alternative, a cofferdam would be constructed near the north end of the Upper Harbor to close off Slip No. 3 and the northwest portion of the Upper Harbor. A slurry cutoff wall would be constructed inside the cofferdam and around the perimeter of the enclosed area to contain PCBs in-place. The cutoff wall would extend into the glacial till to minimize uncontrolled dispersion of PCBs into the groundwater.

A sediment dispersal control device, consisting of a double silt curtain or sheet piling, would be installed at the south end of the Upper Harbor. Sediments with PCB concentrations greater than 50 ppm would then be dredged from the rest of the Upper Harbor and placed within the containment area. This alternative would control almost 100 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor area. If a 95 percent removal efficiency were achieved, this would transfer an estimated 4,400 lb of PCBs contained in approximately 33,500 yd^3 of sediments from the Upper Harbor to the containment area.

Dredged sediments would be dewatered, with the supernatant processed through a package water treatment plant to PCB levels below 1 ppb. The contained area would be capped with impermeable materials to seal in the contaminated materials.

Based on Mason & Hanger's equation for calculation of dispersion of PCBs (001), migration through a 2-ft slurry wall with an overall permeability of 10^{-7} cm/sec would be expected to take 2 years, dispersing about 0.001 lb/yr PCBs. If the slurry wall were cracked by the fluctuating water table, freezing, or other natural phenomena, PCBs could escape at a higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the slurry wall. The State would be required to provide maintenance under PL 96-510.

Using Mason & Hanger's equation (001), migration through a 1-ft-thick layer of glacial till with an overall permeability of 10^{-7} cm/sec would be expected to take 1 year, dispersing about 0.008 lb/yr PCBs. If sandy zones were encountered in the glacial till, PCBs could escape at a higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the glacial till. The State would be required to provide maintenance under PL 96-510.

The site would be capped with impermeable materials to seal in the contaminated soils. Capping would reduce percolation into the contaminated area. Future construction projects that would cause disturbance to the surface and underlying soils (trenching, drilling, digging, etc.) would not be allowed, to minimize deterioration of the impermeable barriers.

Containment and capping would reduce the environmental hazards now posed by PCB contamination in the harbor. All contaminated sediments in Slip No. 3 and the enclosed portion of the Upper Harbor would be contained in-place, and 95 percent removal efficiency of PCBs would be achieved in the rest of the Upper Harbor. The reliability of the slurry wall and capping technologies and the glacial till is discussed in the Reliability section below.

Containment of Slip No. 3 and the Upper Harbor in this manner would require a USEPA waiver from the requirements of 40 CFR 761 of TSCA, since PCBs would remain in proximity to Lake Michigan and in an area with a high groundwater table (058).

This alternative would have greater land use impacts than Slip No. 3 and the Upper Harbor alternatives. Slip No. 3 and a portion of the Upper Harbor would no longer exist and would be converted into a parking lot. Future uses of the new area (and possibly use of some adjacent areas) would be restricted because soil-disturbing construction activities could not be allowed. A new basin would be constructed on vacant OMC property to the east of Slip No. 3. Larsen Marine Services would have to be relocated adjacent to the new basin.

Duration of Cleanup Activities

Cofferdam and slurry wall construction at the north end of the Upper Harbor would require about 3 months. An additional month would be required for dredging in the Upper Harbor. If the water treatment plant were not protected against freezing weather, the containment area would not be able to release slurry water to the plant during freezing conditions. Dredging would then have to occur during nonfreezing weather.

Surcharging would extend 6 to 12 months after dredging activities are completed. Removal of the surcharge and capping of the dewatered sediments would require about 1 month. Construction of the new boat basin would require about 4 months, concurrent with surcharging. Total project duration is estimated to be 11 to 17 months.

Impacts and Mitigation of Cleanup Activities

Dredging. Roiling of bottom sediments during dredging results in sediment suspension and dispersion. The use of a hydraulic dredge and the proper dredge head would minimize roiling and sediment dispersion. A sediment dispersal control system (double silt curtain or steel sheet piling) would also be employed to minimize migration of suspended PCBs out of the dredging area. To assist in controlling sediment dispersion, water would be continually pumped from inside the contained area during construction to maintain net inflow at the south end of the Upper Harbor. This would tend to keep sediments from crossing the control barrier. The water could be treated by addition of polymer and/or activated carbon before the sediment barrier is removed.

A program would be established to monitor the effectiveness of the containment measures and to warn of the need for polymer addition or shutdown of dredging. A seiche warning arrangement with the National Weather Service would also be put in place so operations could be suspended if a seiche were imminent. The containment devices would be the most likely to fail during a seiche due to the forces created by a sudden difference in water level between the two sides of the sheet piling or double silt curtain.

The City of Waukegan maintains an emergency water intake in Waukegan Harbor. This water intake, while an integral part of the Waukegan Harbor system, is rarely used. Project activities would be expected to be completed while the intake was not in use. If, however, the intake was needed during project activities, a monitoring program, including sampling of raw and finished water, would be established during the project to ensure the safety of the supply. A contingency plan would also be established to stop project operations if any contamination entered the system.

Larsen Marine Services would be seriously affected by this alternative. Cofferdam construction would permanently cut off access to its dock. To prevent further spread of PCBs, the new boat basin should not be opened until the Upper Harbor dredging is complete. It is estimated that there would be a 4-month period during which neither Slip No. 3 nor the new boat basin would be available for Larsen Marine Services' operations. Temporary facilities would have to be provided, most probably on the east side of the Upper Harbor south of the proposed boat basin. In addition, a number of Larsen Marine Services docks and service facilities would have to be relocated. The overall short-term impact on Larsen Marine Services would be greater for this alternative than for Alternatives 2B, 2D, and 3. This could be partially offset by the long-term advantages that may accrue to Larsen Marine Services, since the new boat basin geometry could be designed to improve water accessibility.

Minimal volatilization would be expected to occur during dredging activities. Losses would be expected to be roughly 0.3 to 0.4 lb/day/acre from the exposed, agitated, and contaminated water area (030). Concentrations of less than 2 ug/m^3 would be expected to be present in the air as a result of dredging activities (007). By comparison, the

OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m³ in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m³ in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

The proposed dredging would affect terrestrial biota. Populations of gulls and terns that currently reside and feed in the vicinity of the harbor would be disturbed by increased noise and activity levels and may move to another area along the shoreline of Lake Michigan during the times of the day when disturbances would occur. However, because none of these species breeds in the immediate vicinity of the harbor, no long-term displacement of populations is anticipated (048).

Some species of birds or other animals could come into contact with the contaminated sediments and water in the harbor and dewatering lagoon, particularly during non-working hours (gulls) and autumn migration periods (waterfowl and shorebirds) (048).

Changes in the harbor water column PCB concentrations and reduced PCB accumulations in fish would be the two principal long-term beneficial impacts of dredging.

Possible short-term adverse impacts of dredging would include the following:

- The area inside the sediment dispersal control device used to detain roiled sediments would become turbid during dredging and would very likely become anoxic in the pre-dawn hours following a day of dredging in organic "muck" sediments. Indications are that "disturbances" of polluted bottom sediments, especially if they have great quantities of reduced compounds dissolved in the interstitial waters, can elevate the expression of sediment oxygen demand by as much as one order of magnitude. Diurnal rhythms of respiration/photosynthesis in freshwater algae are such that the lowest oxygen levels occur in pre-dawn hours. Consequently, almost all respiring organisms inside the silt curtains would be driven out or may die during early morning hours after dredging (048).

- If dredging occurs during the fall and spring, there is a good chance that spawning fish may be present in the harbor during the dredging activities. Chinook making fall runs may be able to swim around or leap over the silt curtains into a highly PCB-laden body of water (048).

Dewatering. Some volatilization of PCBs would occur during dewatering of the dredged sediments. PCB volatilization would be minimized during initial placement of the dredged sediments by the decanting water layer. The estimated volatilization rate from exposed Upper Harbor sediments with a typical concentration of 100 ppm PCBs would be less than 1 lb of PCBs per day. Volatilization from the less contaminated decanting water layer would also be less than 1.0 lb/day (007, 033).

After completion of dredging, water removal and treatment would continue until settlement of the top of the dredged sediments slowed to a negligible rate. The contained area would then be covered by filter fabric, a granular drainage blanket with drain pipes, and a compacted clay cap and surcharge. This would eliminate the volatilization potential from the containment area. Water removed from the drainage system would have to be treated to remove PCBs until surcharge removal. The drainage pipes would then be permanently plugged.

Water Treatment. All PCB-contaminated waters from the dewatering process would be processed through a package water treatment plant. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct the water quality analyses. Effluent would be discharged into Lake Michigan or to a sanitary sewer. Water discharged into the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Borrow Materials. Cofferdam, drain, cap, and surcharge construction would require filling with clean material. This would require soils removal from an offsite borrow pit, causing topographic and other minor local impacts to the borrow area.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, dredging, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Recreation. The noise and traffic congestion associated with construction activities could have short-term negative impacts on the public beach adjacent to the project area.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Slurry Walls. Slurry walls are a relatively new construction technique, in general use for about 20 years. The technology of construction is well developed, but long-term performance data on the use of slurry walls as a seepage cutoff are not available. While it is generally expected that slurry walls would be relatively impervious, it is possible that "windows" of more permeable material could develop during slurry wall construction. Trench backfill is done below the surface of the slurry, so that visual inspection of the backfill as it reaches its final position is not possible. In addition, the upper part of the completed slurry wall could be cracked by freezing, groundwater fluctuations, or other natural phenomena. The literature on the effect of PCBs on slurry wall permeability is limited. It is anticipated that there would be no significant effects, since clay is generally accepted as a liner for licensed PCB disposal sites. However, the types of slurry wall available should be reviewed during design. If the slurry wall failed to achieve the overall average permeability desired, movement of PCB-contaminated groundwater could occur more rapidly than anticipated. On the other hand, slurry walls have been used for groundwater control on many projects and have a good performance record. The containment area would be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment could be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry wall below the frostline.
- Use of a flexible membrane for the cap could be considered for more freedom in site grading.
- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination of the Waukegan area and Lake Michigan. The type of slurry wall material should also be evaluated during design. Overall, the reliability of slurry walls to reduce the movement of PCB-contaminated groundwater is considered good.

Glacial Till. The glacial till covering the bedrock in the Waukegan area is unsorted, glacier-deposited sediment, consisting of silt, clay, and lenses of sand, in which pebbles, cobbles, and boulders are embedded. The thickness of the glacial till typically ranges from 50 to more than 100 ft.

Because of the relatively low permeability of the glacial till, dissolved substances would be unlikely to migrate more than 20 to 30 ft, unless they reached a sandy zone of higher permeability. These zones could permit deeper migration of dissolved substances (058). Diffusion (the natural force acting to minimize concentration differences) may also disperse dissolved PCBs in the glacial till pore water.

Because of the limited information available at the time they prepared their report, Mason & Hanger did not recommend any alternatives that depended on the underlying glacial till to contain the more concentrated PCB materials (001). Mason & Hanger recommended additional studies be performed to determine the reliability of the glacial till.

PCBs are heavier than water. The PCBs could gravitate down through the glacial till as evidenced by the PCB penetration into the glacial till immediately adjacent to former OMC discharge points in Slip No. 3 (001). PCB concentration decreases rapidly with depth into the glacial till, dropping off to a few ppm after 5 ft of depth in Slip No. 3 (008).

Dredging. Hydraulic dredges have been widely used in the past for dredging. No new technologies are proposed to complete the dredging. Dredging technology is well developed, and the reliability of the equipment to remove sediments from the Upper Harbor and transport them to the containment area is high. If a stoppage of the hydraulic dredge occurs during dredging, it is expected to result in some temporary additional suspension of sediment in the water column due to interruption in hydraulic flow. Leakage or rupture of the hydraulic dredge discharge pipeline could disperse PCB-laden water and sediment over previously uncontaminated areas along he pipeline. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill. A contingency plan would be established for prompt cleanup. Leakage could either be eliminated by pipe joint tightening or be controlled by joint caulking, mats, collection containers, or similar means. The collected solids could be disposed of in the containment area, and collected water could be taken to the water treatment plant.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Capping. The use of compacted clay as liners and caps for chemical waste landfills is a well-developed technology. The use of asphaltic concrete as a runoff-accelerating membrane is also well developed. The clay cap could develop cracks due to moisture content variations, settlement, freezing, or other natural phenomena. The asphaltic concrete cap would be used to help reduce the possibility of soil moisture changes, thus reducing the possibility of developing cracks in the clay cap. It is anticipated that the asphaltic concrete membrane would require periodic maintenance to seal cracks that will inevitably develop as the pavement ages.

The impact of cracking of the cap system would be to allow additional surface water to infiltrate the ground, and possibly to permit minor amounts of volatilized PCBs to leave the containment area. If infiltration increased, it could provide hydraulic head inside the contained area that would increase the flow of PCB-contaminated groundwater from inside the contained area to the surrounding or underlying soil. This would result in further PCB contamination of adjacent and underlying soil. The amount of any such uncontrolled release would be expected to be very small. Overall, the reliability of the cap would be considered good.

Permit Requirements

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- Waukegan Port Authority dredging permit
- IEPA permit for construction of wastewater treatment facilities
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- IDOT (Division of Waterways) permit for work in public waterways
- City of Waukegan construction permits
- Local land use approval
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

<u>Alternative 6B: Contain-Dredge Part of Upper Harbor-Cap</u>

Response Objectives

Under this alternative, a cofferdam would be constructed to separate Slip No. 3 from the Upper Harbor. A slurry cutoff wall would be constructed inside the cofferdam and around the perimeter of the slip to contain PCBs in-place. The cutoff wall would extend into the glacial till to minimize uncontrolled dispersion of PCBs into the groundwater.

A sediment dispersal control device, consisting of a double silt curtain or sheet piling, would be installed near the middle of the Upper Harbor. Approximately 13,100 yd^3 of sediments with PCB concentrations greater than 50 ppm would then be dredged from the north part of the Upper Harbor and placed within the containment area. If a 95 percent removal efficiency were achieved, this would transfer an estimated 3,600 lb of PCBs to the containment area. This alternative would control 99 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor area. Because of the limited containment area, a smaller volume of sediments would be dredged from the Upper Harbor than under the other alternatives. This alternative would not remove approximately 25,500 yd^3 of sediments containing 3,100 lb of PCBs with concentrations between 50 and 150 ppm in the Upper Harbor. However, these PCBs represent less than 1 percent of the PCBs now found in Slip No. 3 and the Upper Harbor area.

Dredged sediments would be dewatered, with the supernatant processed through a package water treatment plant to PCB levels below 1 ppb. The contained area would be capped with impermeable materials to seal in the contaminated materials.

Using Mason & Hanger's equation for dispersion of PCBs (001), migration through a 2-ft slurry wall with an overall permeability of 10^{-7} cm/sec would be expected to take 2 years, dispersing about 0.0006 lb/yr PCBs. If the slurry wall were cracked by the fluctuating water table, freezing, or other natural phenomena, PCBs could escape at a higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the slurry wall. The State would be required to provide maintenance under PL 96-510.

Using Mason & Hanger's equation (001), migration through a 1-ft-thick layer of glacial till with an overall permeability of 10^{-7} cm/sec would be expected to take 1 year, dispersing about 0.003 lb/yr PCBs. If sandy zones were encountered in the glacial till, PCBs could escape at a higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the glacial till. The State would be required to provide maintenance under PL 96-510.

The site would be capped with impermeable materials to seal in the contaminated soils. Capping would reduce percolation into the contaminated area. Future construction projects that would cause disturbance to the surface and underlying soils (trenching, drilling, digging, etc.) would not be allowed, to minimize deterioration of the impermeable barriers.

Containment and capping would reduce the environmental hazards now posed by PCB contamination in the harbor. All contaminated sediments in the western portion of Slip No. 3 would be contained in-place, and 95 percent removal efficiency of PCBs would be achieved in the eastern portion of Slip No. 3 and the northern portion of the Upper Harbor. The reliability of the slurry wall and capping technologies and the glacial till is discussed in the Reliability section below.

Containment of Slip No. 3 in this manner would require a USEPA waiver from the requirements of 40 CFR 761 of TSCA, since PCBs would remain in proximity to Lake Michigan and in an area with a high groundwater table (058).

This alternative would have greater land use impacts than Slip No. 3--Alternatives 2B, 2D, and 3. Slip No. 3 would no longer exist and would be converted into a parking lot. Future uses of the new area over the slip (and possibly use of some adjacent areas) would be restricted because soil-disturbing construction activities could not be allowed. A new basin would be constructed on vacant OMC property to the east of Slip No. 3. Larsen Marine Services would have to be relocated adjacent to the new basin.

Duration of Cleanup Activities

Cofferdam and slurry wall construction at the mouth of Slip No. 3 would require about 2 months. An additional month would be required for dredging in the Upper Harbor. If the water treatment plant were not protected against freezing weather, the containment area would not be able to release slurry water to the plant during freezing conditions. Dredging would then have to occur during nonfreezing weather.

Surcharging would extend 6 to 12 months after dredging activities are completed. Removal of the surcharge and capping of the dewatered sediments would require about 1 month. Construction of the new boat basin would require about 4 months, concurrent with surcharging. Total project duration is estimated to be 10 to 16 months.

Impacts and Mitigation of Cleanup Activities

Dredging. Roiling of bottom sediments during dredging results in sediment suspension and dispersion. The use of a hydraulic dredge and the proper dredge head would minimize roiling and sediment dispersion. A sediment dispersal control system (double silt curtain or steel sheet piling) would also be employed to minimize migration of suspended PCBs out of the dredging area. To assist in controlling sediment dispersion, water would be continually pumped from inside the contained area during construction to maintain net inflow at the slip mouth. This would tend to keep sediments from crossing the control barrier. The water could be treated by addition of polymer and/or activated carbon before the sediment barrier is removed.

A program would be established to monitor the effectiveness of the containment measures and to warn of the need for polymer addition or shutdown of dredging. A seiche warning arrangement with the National Weather Service would also be put in place so operations could be suspended if a seiche were imminent. The containment devices would be the most likely to fail during a seiche due to the forces created by a sudden difference in water level between the two sides of the sheet piling or double silt curtain.

The City of Waukegan maintains an emergency water intake in Waukegan Harbor. This water intake, while an integral part of the Waukegan Harbor system, is rarely used. Project activities would be expected to be completed while the intake was not in use. If, however, the intake was needed during project activities, a monitoring program, including sampling of raw and finished water, would be established during the project to ensure the safety of the supply. A contingency plan would also be established to stop project operations if any contamination entered the system.

Larsen Marine Services would be seriously affected by this alternative. Cofferdam construction would permanently cut off access to its dock. To prevent further spread of PCBs, the new boat basin should not be opened until the Upper Harbor dredging is complete. It is estimated that there would be a 4-month period during which neither Slip No. 3 nor the new boat basin would be available for Larsen Marine Services' operations. Temporary facilities would have to be provided, most probably on the east side of the Upper Harbor south of the proposed boat basin. In addition, a number of Larsen Marine Services docks and service facilities would have to be relocated. The overall short-term impact on Larsen Marine Services would be greater for this alternative than for Alternatives 2B, 2D, and 3. This could be partially offset by the long-term advantages that may accrue to Larsen Marine Services, since the new boat basin geometry could be designed to improve water accessibility.

Minimal volatilization would be expected to occur during dredging activities. Losses would be expected to be roughly 0.3 to 0.4 lb/day/acre from the exposed, agitated, and contaminated water area (030). Concentrations of less than 2 ug/m^3 would be expected to be present in the air as a result of dredging activities (007). By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m^3 in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m^3 in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

The proposed dredging would affect terrestrial biota. Populations of gulls and terns that currently reside and feed in the vicinity of the harbor would be disturbed by increased noise and activity levels and may move to another area along the shoreline of Lake Michigan during the times of the day when disturbances would occur. However, because none of these species breeds in the immediate vicinity of the harbor, no long-term displacement of populations is anticipated (048).

Some species of birds or other animals could come into contact with the contaminated sediments and water in the harbor and dewatering lagoon, particularly during non-working hours (gulls) and autumn migration periods (waterfowl and shorebirds) (048).

Changes in the harbor water column PCB concentrations and reduced PCB accumulations in fish would be the two principal long-term beneficial impacts of dredging.

Possible short-term adverse impacts of dredging would include the following:

- The area inside the sediment dispersal control device used to detain roiled sediments would become turbid during dredging and would very likely become anoxic in the pre-dawn hours following a day of dredging in organic "muck" sediments. Indications are that "disturbances" of polluted bottom sediments, especially if they have great quantities of reduced compounds dissolved in the interstitial waters, can elevate the expression of sediment oxygen demand by as much as one order of magnitude. Diurnal rhythms of respiration/photosynthesis in freshwater algae are such that the lowest oxygen levels occur in pre-dawn hours. Consequently, almost all respiring organisms inside the silt curtains would be driven out or may die during early morning hours after dredging (048).

- If dredging occurs during the fall and spring, there is a good chance that spawning fish may be present in the harbor during the dredging activities. Chinook making fall runs may be able to swim around or leap over the silt curtains into a highly PCB-laden body of water (048).

Dewatering. Some volatilization of PCBs would occur during dewatering of the dredged sediments. PCB volatilization would be minimized during initial placement of the dredged sediments by the decanting water layer. The estimated volatilization rate from exposed Upper Harbor sediments with a typical concentration of 500 ppm PCBs would be less than 1 lb of PCBs per day. The volatilization rate from the less contaminated decanting water layer would also be less than 1 lb/day (007, 030).

After completion of dredging, water removal and treatment would continue until settlement of the top of the dredged sediments slowed to a negligible rate. The contained area would then be covered by filter fabric, a granular drainage blanket with drain pipes, and a compacted clay cap and surcharged. This would eliminate the volatilization potential from the containment area. Water removed from the drainage system would have to be treated to remove PCBs until surcharge removal. The drainage pipes would then be permanently plugged.

Water Treatment. All PCB-contaminated waters from the dewatering process would be processed through a package water treatment plant. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct the water quality analyses. Effluent would be discharged into Lake Michigan or to a sanitary sewer. Water discharged into the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Borrow Materials. Cofferdam, drain, cap, and surcharge construction would require filling with clean material. This would require soils removal from an offsite borrow pit, causing topographic and other minor local impacts to the borrow area.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, dredging, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Recreation. The noise and traffic congestion associated with construction activities could have short-term negative impacts on the public beach adjacent to the project area.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (see Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Slurry Walls. Slurry walls are a relatively new construction technique, in general use for about 20 years. The technology of construction is well developed, but long-term performance data on the use of slurry walls as a seepage cutoff are not available. While it is generally expected that slurry walls would be relatively impervious, it is possible that "windows" of more permeable material could develop during slurry wall construction. Trench backfill is done below the surface of the slurry, so that visual inspection of the backfill as it reaches its final position is not possible. In addition, the upper part of the completed slurry wall could be cracked by freezing, groundwater fluctuations, or other natural phenomena. The literature on the effect of PCBs on slurry wall permeability is limited. It is anticipated that there would be no significant effects, since clay is generally accepted as a liner for licensed PCB disposal sites. However, the types of slurry wall available should be reviewed during design. If the slurry wall failed to achieve the overall average permeability desired, movement of PCB-contaminated groundwater could occur more rapidly than anticipated. On the other hand, slurry walls have been used for groundwater control on many projects and have a good performance record. The containment area would be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment could be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry wall below the frostline.

- Use of a flexible membrane for the cap could be considered for more freedom in site grading.

- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination of the Waukegan area and Lake Michigan. The type of slurry wall material should also be evaluated during design. Overall, the reliability of slurry walls to reduce the movement of PCB-contaminated groundwater is considered good.

Glacial Till. The glacial till covering the bedrock in the Waukegan area is unsorted, glacier-deposited sediment, consisting of silt, clay, and lenses of sand in which pebbles, cobbles, and boulders are embedded. The thickness of the glacial till typically ranges from 50 to more than 100 ft.

Because of the relatively low permeability of the glacial till, dissolved substances would be unlikely to migrate more than 20 to 30 ft, unless they reached a sandy zone of higher permeability. These zones could permit deeper migration of dissolved substances (058). Diffusion (the natural force acting to minimize concentration differences) may also disperse dissolved PCBs in the glacial till pore water.

Because of the limited information available at the time they prepared their report, Mason & Hanger did not recommend any alternatives that depended on the underlying glacial till to contain the more concentrated PCB materials (001). Mason & Hanger recommended additional studies be performed to determine the reliability of the glacial till.

PCBs are heavier than water. The PCBs could gravitate down through the glacial till as evidenced by the PCB penetration into the glacial till immediately adjacent to former OMC discharge points in Slip No. 3 (001). PCB concentration decreases rapidly with depth into the glacial till, dropping off to a few ppm after 5 ft of depth in Slip No. 3 (008).

Dredging. Hydraulic dredges have been widely used in the past for dredging. No new technologies are proposed to complete the dredging. Dredging technology is well developed, and the reliability of the equipment to remove sediments from the Upper Harbor and transport them to the containment area is high. If a stoppage of the hydraulic dredge occurs during dredging, it is expected to result in some temporary additional suspension of sediment in the water column due to interruption in hydraulic flow. Leakage or rupture of the hydraulic dredge discharge pipeline could disperse PCB-laden water and sediment over previously uncontaminated areas along he pipeline. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill. A contingency plan would be established for prompt cleanup. Leakage could either be eliminated by pipe joint tightening or be controlled by joint caulking, mats, collection containers, or similar means. The collected solids could be disposed of in the containment area, and collected water could be taken to the water treatment plant.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Capping. The use of compacted clay as liners and caps for chemical waste landfills is a well-developed technology. The use of asphaltic concrete as a runoff-accelerating membrane is also well developed. The clay cap could develop cracks due to moisture content variations, settlement, freezing, or other natural phenomena. The asphaltic concrete cap would be used to help reduce the possibility of soil moisture changes, thus reducing the possibility of developing cracks in the clay cap. It is anticipated that the asphaltic concrete membrane would require periodic maintenance to seal cracks that will inevitably develop as the pavement ages.

The impact of cracking of the cap system would be to allow additional surface water to infiltrate the ground, and possibly to permit minor amounts of volatilized PCBs to leave the containment area. If infiltration increased, it could provide hydraulic head inside the contained area that would increase the flow of PCB-contaminated groundwater from inside the contained area to the surrounding or underlying soil. This would result in further PCB contamination of adjacent and underlying soil. The amount of any such uncontrolled release would be expected to be very small. Overall, the reliability of the cap would be considered good.

Permit Requirements

Permit requirements are anticipated to include:

- USCOE Section 10 (dredging) permit
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- Waukegan Port Authority dredging permit
- IEPA permit for construction of wastewater treatment facilities
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- IDOT (Division of Waterways) permit for work in public waterways
- City of Waukegan construction permits
- Local land use approval
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

Subalternative I: Select Excavation

Response Objectives

This alternative would be used only in conjunction with Alternative 6A or 6B. The deep contaminated sediments in the localized area of Slip No. 3 (near the former OMC outfall) would be removed by clamshell dredging, fixed, and disposed of offsite. No dewatering of these dredged sediments would occur. Containment, dredging of Upper Harbor sediments, and capping would then occur as described under Alternative 6A or 6B.

Because sediments with the greatest PCB concentrations would be removed (about 286,500 lb of PCBs in 2,000 yd^3 of sediments and 3,700 yd^3 of deep contaminated sand and silt), this variation would reduce the potential impacts of possible PCB migration or escape through the slurry wall and the glacial till (see discussion under Alternatives 6A and 6B). Subalternative I would remove and dispose of offsite approximately 92.4 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor area.

Duration of Cleanup Activities

The dredging of deep contaminated sediments in Slip No. 3 would add about 2 months to the cleanup activities of Alternative 6A or 6B. Total project duration is therefore estimated to be 13 to 19 months for 6A and Subalternative I and 12 to 18 months for 6B and Subalternative I.

Impacts and Mitigation of Cleanup Activities

Clamshell Dredging. Spillage of 15 to 30 percent of the sediments in a clamshell bucket occurs while it is being raised. This spillage creates a high degree of sediment suspension that increases the concentration of PCBs in solution. A sheet pile cofferdam would be employed to support the excavation sides and contain these dredging activities. The water would be treated by the addition of powdered activated carbon to remove dissolved PCBs before the cofferdam sediment barrier was removed. The water level inside the cofferdam would be lowered to create net inflow as an additional control measure. After excavation of the localized area was complete, the cofferdam would be removed and the remaining portion of the western 200 ft of Slip No. 3 would be dredged with a clamshell.

Minimal volatilization would be expected to occur during these dredging activities. Losses would be expected to be roughly 0.3 to 0.4 lb/day/acre from the exposed, agitated, and contaminated water area (030). Concentrations of less than 1 ug/m³ are expected to be present in the air as a result of dredging activities (007). By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m³ in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m³ in the air during an 8-hour period (007).

Solids Removal, Fixation, and Disposal. Volatilization is expected to occur during truck loading of dredged sediments for transport to the batch plant. The highest reported concentration in Slip No. 3 sediments is about 100,000 ppm PCB. The maximum predicted PCB concentration in the air from solids removal operations is predicted to be less than 200 ug/m³ (007). These values were extrapolated from data for sand assuming a 3.6-mph wind and an air temperature of 68°F. The volatilization rate from Waukegan Harbor muck should be less than from sand (007).

Dewatered sediment would be fixed into a nonflowable form for offsite transport by truck. A sufficient amount of fixing agent would be used to prevent water loss, and covers may be required to prevent volatilization during transport. Rules and regulations controlling the transport of toxic materials promulgated by the USDOT, USEPA, IDOT, IINR, and other applicable regulatory agencies would be complied with. These include cleanup, safety, and spill prevention and response measures.

Offsite disposal of fixed dredged sediments would require approximately 710 truck trips to the disposal site using a 10-yd³ capacity truck. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic, but some roadway congestion and roadway damage could occur (048). Some species of terrestrial animals could come into contact with contaminated materials if any loss occurs during transport, and the contamination could be passed into other terrestrial food chains (048).

Disposal of the materials would be in a licensed chemical waste landfill, and would be in compliance with State and Federal standards for PCB waste disposal.

Reliability

Clamshell Dredging. Clamshell dredges have been widely used in the past for dredging. No new technologies are proposed to complete the dredging. Dredging technology is well developed, and the reliability of the equipment to remove sediments from the slip and transport them to the batch plant would be high.

Glacial Till. The glacial till covering the bedrock in the Waukegan area is unsorted, glacier-deposited sediment, consisting of silt, clay, and lenses of sand, in which pebbles, cobbles, and boulders are embedded. The thickness of the glacial till typically ranges from 50 to more than 100 ft (058).

Because of the relatively low permeability of the glacial till, dissolved substances would be unlikely to migrate more than 20 to 30 ft, unless they reached a sandy zone of higher permeability. These zones could permit deeper migration of dissolved substances (058). Diffusion (the natural force acting to minimize concentration differences) may also disperse dissolved PCBs in the glacial till pore water.

Because of the limited information available at the time they prepared their report, Mason & Hanger did not recommend any alternatives that depended on the underlying glacial till to contain the more concentrated PCB materials (001).

Mason & Hanger recommended additional studies be performed to determine the reliability of the glacial till.

PCBs are heavier than water. The PCBs could gravitate down through the glacial till as evidenced by the PCB penetration into the glacial till immediately adjacent to former OMC discharge points in Slip No. 3 (001, 008, 016). The PCB concentration decreases rapidly with depth into the glacial till, dropping off to a few ppm after 5 ft of depth in Slip No. 3 (008). Removing the very high concentrations of PCBs near the OMC outfall in Slip No. 3 would remove the area where the PCBs have been known to migrate into the glacial till.

Curing Cells. The technology for construction of lined curing cells is well developed and feasible. There are no unusual construction details for the curing cell construction. Construction could be accomplished using conventionally available materials and equipment. The risk of failure would be low. If the upper clay liner failed, contaminated leachate could be collected by the underdrain system. If the lower clay liner also failed, contaminated soil would have to be excavated and disposed of with the other contaminated solids.

If an exterior curing cell dike failed while a cell was filled with incompletely cured fixed solids, PCB-contaminated water and sediment could flow over a small area, requiring cleanup operations and causing slightly increased volatilization. The technology for dike design is well understood, however, so the probability of dike failure would be extremely low.

Fixation. Fixation would use existing equipment in an application similar to previous applications, but not yet established for these high-moisture-content sediments. Laboratory testing is now being conducted to verify that fixation can be accomplished with existing available materials and equipment. It is anticipated that fixation will prove to be a technically feasible and reliable means of controlling water loss. If fixation failed to prevent water loss, then solids would have to be dewatered mechanically, as proposed for Alternative 3, or a waiver from that requirement of 40 CFR 761 would have to be obtained from the USEPA Regional Administrator.

Transportation. Transportation would be accomplished using dump trucks. Failure could occur by loss of material from the truck through leakage, spilling over the top, dusting, volatilization, or spills resulting from vehicle accidents.

The impact of leakage, dusting, and volatilization would be to disperse small amounts of PCBs all along the haul routes.

These types of uncontrolled release could be minimized by the use of tailgate seals and covers.

The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more isolated points. The risk of spills over the top of the truck could be minimized by use of a cover. The risk of vehicle accidents is relatively small, but it could be compensated for by having a response plan and team ready during hauling.

Permit Requirements

The following permits would be required in addition to those listed under Alternatives 6A and 6B.

- IEPA (Division of Land and Noise) special waste hauler's permit
- Certification of Authority to haul PCB commodities (ICC and IICC)

NORTH DITCH/PARKING LOT AREA

Alternative 1: Excavate-Dispose

Response Objectives

This alternative would remove all soils with concentrations of PCBs greater than 50 ppm from the North Ditch/Parking Lot area. If a 98 percent removal efficiency were achieved, it would remove an estimated 757,700 lb of PCBs in approximately 175,800 yd^3 of soil (003). This alternative would significantly reduce the discharge of PCBs into Lake Michigan, the potential for future groundwater contamination, and the volatilization of PCBs into the airshed.

All former land and water uses would be able to resume after cleanup activities are completed. No restrictions to future uses would be expected.

Duration of Cleanup Activities

Construction of the structural and nonstructural slurry walls at the Crescent Ditch, Oval Lagoon, and the Parking Lot area is expected to take a total of 2 to 3 months. Installation of the groundwater pumping system and initial groundwater lowering is expected to take 1 to 2 months. Excavation, transportation, and backfilling is expected to take a total of about 5 months. If the water treatment plant was not protected against freezing weather, dewatering effluent could not be released to the plant during freezing conditions. Construction below the water table would then have to take place during nonfreezing weather. The overall duration for this alternative is estimated to be 9 months.

Impacts and Mitigation of Cleanup Activities

Excavation. Soils with PCB concentrations in excess of 50 ppm would be excavated by backhoe or front end loader and loaded onto trucks for offsite disposal. Excavation of contaminated soils would also be required for construction of the North Ditch bypass and installation of the well points to control surface water and groundwater.

Volatilization that would occur during these activities could be minimized by employing the following mitigation measures:

- Keeping the area exposed by excavation as small as possible.
- Performing the work in as short a time as possible, by using more or larger equipment.
- Covering the exposed material not at the working face with organic materials (such as digested activated sludge, manure, paper mill sludge) or with synthetic liners.
- Performing the work in the winter, since the rate of volatilization during cold weather is less than during warm weather.

The highest reported concentration in the North Ditch soils is about 100,000 ppm (001). The predicted PCB concentration in air during excavation would be about 200 ug/m^3. The volatilization rate is predicted to be about 163,000 $ug/m^2/hr$. Typical concentrations range from 50 to 5,000 ppm. Predicted average PCB concentrations in the air would be less than 6.6 ug/m^3. The average volatilization rate is expected to be less than 5,375 $ug/m^2/hr$ for soils with concentrations of 1,000 ppm PCBs. The highest reported concentration in Parking Lot area soils is less than 10,000 ppm (001). The predicted PCB concentration in air during excavation would be less than 43 ug/m^3, well below 1,000 ug/m^3, the OSHA standard. The volatilization rate is predicted to be less than 35,000 $ug/m^2/hr$. Typical concentrations range from 50 to 5,000. Predicted average PCB concentrations in the air would be about 6.6 ug/m^3. The average volatilization rate is expected to be about 5,375 $ug/m^2/hr$. These values were extrapolated from data for sand assuming a 3.6-mph wind and an air temperature of 68°F (007). The volatilization rates from the sandy soils of the North Ditch/Parking Lot area are expected to be approximated by these predictions. By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m^3 in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m³ in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

Animals could be disturbed or affected by construction activities that would alter or remove their habitats and affect their normal daily and seasonal activities. However, such changes would be expected to affect relatively few species and individuals and would be far outweighed by the benefits to be gained from removal of the contaminated material. Shorebirds, gulls, and possibly other species could be attracted to the excavated areas (048).

Water Treatment. The groundwater removed by pumping from the well points would be fully contained and processed through a package water treatment plant. Secondary solids discharged from the water treatment plant would be treated with other area solids. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct the water quality analyses. Effluent would be discharged into Lake Michigan or a sanitary sewer. Water discharged to the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Backfill of Excavated Areas. The backfill of excavated areas would require soils removal from an offsite borrow pit, causing topographic and other minor local impacts to the borrow area.

Solids Removal and Disposal. Excavated soil would be transported by truck to an offsite disposal site. The trucks would have to be lined to prevent leakage. Cover or closure of the trucks would prevent spillage and volatilization during transport. Rules and regulations controlling the transport of toxic materials promulgated by the USDOT, USEPA, IDOT, IINR, and other applicable regulatory agencies would be complied with. These include cleanup, safety, and spill prevention and response measures.

Offsite disposal of excavated soil would require approximately 17,580 truck trips to the disposal site using a 10-yd³ capacity truck. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic, but some roadway congestion and roadway damage could occur (048). Some species of terrestrial animals could come into contact with contaminated materials if any loss occurs during transport, and the contamination could be passed into other terrestrial food chains (048).

Disposal of the excavated soil would be in a licensed chemical waste landfill, and would be in compliance with State and Federal standards for PCB waste disposal. PCB materials with concentrations greater than 50 ppm must be nonflowable if they are to be disposed of in a chemical waste landfill (40 CFR 761). This alternative assumes that the contaminated soils can be excavated in a nonflowable state, since they are mostly sand.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, excavation, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Recreation. The noise and traffic congestion associated with construction activities could have short-term negative impacts on the public beach adjacent to the project area.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (see Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Excavation. Excavation would be accomplished using backhoes and front end loaders. Conventionally available devices based on well-developed technology are feasible for the proposed use. Failure could occur by loss of material during excavation as a result of power loss, accident, or spilling. Where material falls back into the working excavation, there would be essentially no impacts. The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more points on the site. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Transportation. Transportation would be accomplished using dump trucks. Failure could occur by loss of material from the truck through leakage, spilling over the top, dusting, volatilization, or spills resulting from vehicle accidents.

The impact of leakage, dusting, and volatilization would be to disperse small amounts of PCBs all along the haul routes. These types of uncontrolled release could be minimized by the use of tailgate seals and covers.

The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more isolated points. The risk of spills over the top of the truck could be minimized by use of a cover. The risk of vehicle accidents is relatively small, but it could be compensated for by having a response plan and team ready during hauling.

Permit Requirements

Permit requirements are anticipated to include:

- Well water removal permit (State)
- IEPA permit for construction of wastewater treatment facilities

- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits
- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and IlCC)
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

Alternative 3: Excavate-Fix-Dispose

Response Objectives

This alternative would remove all soils with PCB concentrations greater than 50 ppm from the North Ditch/Parking Lot area. If a 98 percent removal efficiency were achieved, it would remove an estimated 757,700 lb of PCBs in approximately 175,800 yd^3 of soil (003). This alternative will significantly reduce the discharge of PCBs into Lake Michigan, the potential for future groundwater contamination, and the volatilization of PCBs into the airshed.

All former land and water uses would be able to resume after cleanup activities are completed. No restrictions to future uses would be expected.

Duration of Cleanup Activities

Construction of the structural and nonstructural slurry walls at the Crescent Ditch, Oval Lagoon, and Parking Lot area is expected to take a total of 2 to 3 months. Installation of the groundwater pumping system and initial groundwater lowering is expected to take 1 to 2 months. Excavation is expected to take about 5 months. Fixing, transportation, and backfilling could occur concurrently with excavation. If the water treatment plant was not protected against freezing weather, dewatering effluent could not be released to the plant during freezing conditions. Construction below the water table would then have to take place during nonfreezing weather. The overal duration for this alternative is estimated to be 9 months.

Impacts and Mitigation of Cleanup Activities

Excavation. Soils with PCB concentrations in excess of 50 ppm would be excavated by backhoe or front end loader and loaded onto trucks for offsite disposal. Excavation of contaminated soils would also be required for construction of the North Ditch bypass and installation of the well points to control surface water and groundwater.

Volatilization that would occur during these activities could be minimized by employing the following mitigation measures:

- Keeping the area exposed by excavation as small as possible.
- Performing the work in as short a time as possible, by using more or larger equipment.
- Covering the exposed material not at the working face with organic materials (such as digested activated sludge, manure, paper mill sludge) or with synthetic liners.
- Performing the work in the winter, since the rate of volatilization during cold weather is less than during warm weather.

The highest reported concentration in the North Ditch soils is about 100,000 ppm (001). The predicted PCB concentration in air during excavation would be about 200 ug/m³. The volatilization rate is predicted to be about 163,000 ug/m²/hr. Typical concentrations range from 500 to 5,000 ppm. Predicted average PCB concentrations in the air would be less than 6.6 ug/m³. The average volatilization rate is expected to be less than 5,375 ug/m²/hr for soils with concentrations of 1,000 ppm PCBs. The highest reported concentration in Parking Lot area soils is less than 10,000 ppm (001). The predicted PCB concentration in air during excavation would be less than 43 ug/m³, well below 1,000 ug/m³, the OSHA standard. The volatilization rate is predicted to be less than 35,000 ug/m²/hr. Typical concentrations range from 50 to 5,000. Predicted average PCB concentrations in the air would be about 6.6 ug/m³. The average volatilization rate is expected to be about 5,375 ug/m²/hr. These values were extrapolated from data for sand assuming a 3.6-mph wind and an air temperature of 68°F (007). The volatilization rates from the sandy soils of the North Ditch/Parking Lot area are expected to be approximated by these predictions. By compairson, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m³ in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m³ in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

Animals could be disturbed or affected by construction activities that would alter or remove their habitats and affect their normal daily and seasonal activities. However, such changes would be expected to affect relatively few species and individuals and would be far outweighed by the benefits to be gained from removal of the contaminated material. Shorebirds, gulls, and possibly other species could be attracted to the excavated areas (048).

Water Treatment. The groundwater removed by pumping from the well points would be fully contained and processed through a package water treatment plant. Secondary solids discharged from the water treatment plant would be treated with other area solids. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct the water quality analyses. Effluent would be discharged into Lake Michigan or a sanitary sewer. Water discharged to the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Backfill of Excavated Areas. The backfill of excavated areas would require soils removal from an offsite borrow pit, causing topographic and other minor local impacts to the borrow area.

Solids Removal, Fixation, and Disposal. Excavated soil would be fixed into a nonflowable form for offsite transport by truck. A sufficient amount of fixing agent would be used to prevent water loss during transport. Rules and regulations controlling the transport of toxic materials promulgated by the USDOT, USEPA, IDOT, IINR, and other applicable regulatory agencies would be complied with. These include cleanup, safety, and spill prevention and response measures.

Offsite disposal of excavated soil would require approximately 21,980 truck trips to the disposal site using a 10-yd³ capacity truck. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic, but some roadway congestion and roadway damage could occur (048). Some species of terrestrial animals could come into contact with contaminated materials if any loss occurs during transport, and the contamination could be passed into other terrestrial food chains (048).

Disposal of the fixed materials would be in a licensed chemical waste landfill, and would be in compliance with State and Federal standards for PCB waste disposal. PCB materials with concentrations greater than 50 ppm must be nonflowable if they are to be disposed of in a chemical waste landfill (40 CFR 761). This alternative assumes that the contaminated soils can be excavated in a nonflowable state, since they are mostly sand.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

> Noise. Noise would be produced by construction, excavation, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.
>
> Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.
>
> Recreation. The noise and traffic congestion associated with construction activities could have short-term negative impacts on the public beach adjacent to the project area.
>
> Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Excavation. Excavation would be accomplished using backhoes and front end loaders. Conventionally available devices based on well-developed technology are feasible for the proposed use. Failure could occur by loss of material during excavation as a result of power loss, accident, or spilling. Where material falls back into the working excavation, there would be essentially no impacts. The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more points on the site. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material contaminated by the spill.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Fixation. Fixation would use existing equipment in an application similar to previous applications, but not yet established for these high-moisture-content soils. Laboratory testing is now being conducted to verify that fixation can be accomplished with existing available materials and equipment. It is anticipated that fixation will prove to be a technically feasible and reliable means of controlling water loss. If fixation failed to prevent water loss, then solids would have to be dewatered mechanically, as proposed for Slip No. 3--Alternative 3, or a waiver from that requirement of 40 CFR 761 would have to be obtained from the USEPA Regional Administrator.

Curing Cells. The technology for construction of lined curing cells is well developed and feasible. There are no unusual construction details for the curing cell construction. Construction could be accomplished using conventionally available materials and equipment. The risk of failure would be low. If the upper clay liner failed, contaminated leachate could be collected by the underdrain system. If the lower clay liner also failed, contaminated soil would have to be excavated and disposed of with the other contaminated solids.

If a dike failed while a cell was filled with incompletely cured fixed solids, PCB-contaminated material could flow over a small area, requiring cleanup operations and causing slightly increased volatilization. The technology for dike design is well understood, however, so the probability of dike failure would be extremely low.

Transportation. Transportation would be accomplished using dump trucks. Failure could occur by loss of material from the truck through leakage, spilling over the top, dusting, volatilization, or spills resulting from vehicle accidents.

The impact of leakage, dusting, and volatilization would be to disperse small amounts of PCBs all along the haul routes. These types of uncontrolled release could be minimized by the use of tailgate seals and covers.

The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more isolated points. The risk of spills over the top of the truck could be minimized by use of a cover. The risk of vehicle accidents is relatively small, but it could be compensated for by having a response plan and team ready during hauling.

Permit Requirements

Permit requirements are anticipated to include:

- Well water removal permit (State)
- USCOE Section 404 (disposal in waterways) permit
- IEPA permit for construction of wastewater treatment facilities
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits

- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and IICC).
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

Alternative 4: Contain-Cap (Parking Lot Area Only)

Response Objectives

This alternative would use a slurry wall around the perimeter of the soil with PCB concentrations greater than 50 ppm. The containment wall would extend down to the existing glacial till beneath the local sands (35 ft deep). This would minimize uncontrolled dispersion of PCBs through the soil or the groundwater. Based on Mason & Hanger's equation for dispersion of PCBs (001), if a wall with an overall permeability of 10^{-7} cm/sec were used, migration through a 2-ft slurry wall would be expected to take 2 years, dispersing about 0.002 lb/ year PCBs. If the slurry wall were cracked by the fluctuating water table, freezing, or other natural phenomena, PCBs would escape at a higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the slurry walls. The State would be required to provide maintenance under PL 96-510.

Using Mason & Hanger's equation (001), migration through a 1-ft-thick layer of glacial till with an overall permeability of 10^{-7} cm/sec would be expected to take 1 year, dispersing about 0.02 lb/yr PCBs. If sandy zones were encountered in the glacial till, PCBs could escape at a higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the glacial till. The State would be required to provide maintenance under PL 96-510.

The site would be capped with impermeable materials to seal in the contaminated soils, and would be resurfaced for future parking. Capping would reduce percolation into the contaminated area. Future construction projects that would cause disturbance to the surface and underlying soils (trenching, drilling, digging, etc.) would not be allowed, to minimize deterioration of the impermeable barriers.

This alternative would reduce the environmental hazards now posed by PCB contamination. The reliability of the slurry wall, the underlying glacial till, and capping is discussed in the reliability section below. Because of its proximity to Lake Michigan, the Parking Lot area could experience erosion as a result of storm events. However, a one-time event is not likely to impact the area, and mitigative measures could be taken to prevent cumulative impacts from multiple events.

Containment of the Parking Lot in this manner would require a USEPA waiver from the requirements of 40 CFR 761 of TSCA, since PCBs would remain in proximity to Lake Michigan and in an area with a high groundwater table (058).

This alternative would have greater land use impacts than Alternatives 1 and 3. Future new uses of the Parking Lot area and possibly of some adjacent areas would be restricted because soil-disturbing construction activities could not be allowed.

Duration of Cleanup Activities

Construction of the slurry wall is expected to take about 1 month, with construction of the clay cap and paving taking about 2 months. The overall duration for this alternative is estimated to be 4 months.

Impacts and Mitigation of Cleanup Activities

Excavation. Excavation would be required for construction of the slurry wall and installation of the monitoring wells. Volatilization from excavation of soils with average contaminant levels of 10,000 ppm is estimated to result in air concentrations of 43 ug/m³ (007). By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m³ in the air at any time. However, NIOSH recommends that workers not be exposed to more than 1 ug/m³ in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section).

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, excavation, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Reliability

Slurry Walls. Slurry walls are a relatively new construction technique, in general use for about 20 years. The technology of construction is well developed, but long-term performance data on the use of slurry walls as a seepage cutoff are not available. While it is generally expected that slurry walls would be relatively impervious, it is possible that "windows" of more permeable material could develop during slurry wall construction. Trench backfill is done below the surface of the slurry, so that visual inspection of the backfill as it reaches its final position is not possible. In addition, the upper part of the completed slurry wall could be cracked by freezing, groundwater fluctuations, or other natural phenomena. The literature on the effect of PCBs on slurry wall permeability is limited. It is anticipated that there would be no significant effects, since clay is generally accepted as a liner for licensed PCB disposal sites. However, the types of slurry wall available should be reviewed during design. If the slurry wall failed to achieve the overall average permeability desired, movement of PCB-contaminated groundwater could occur more rapidly than anticipated. On the other hand, slurry walls have been used for groundwater control on many projects and have a good performance record. The containment area would be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment could be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry and cap wall below the frostline.
- Use of a flexible membrane for the cap could be considered for more freedom in site grading.
- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination in the Waukegan area and Lake Michigan. The type of slurry wall material should also be evaluated during design. Overall, the reliability of slurry walls to reduce the movement of PCB-contaminated groundwater is considered good.

<u>Glacial Till</u>. The glacial till covering the bedrock in the Waukegan area is unsorted, glacier-deposited sediment, consisting of silt, clay, and lenses of sand, in which pebbles, cobbles, and boulders are embedded. The thickness of the glacial till typically ranges from 50 to more than 100 ft.

Because of the relatively low permeability of the glacial till, dissolved substances would be unlikely to migrate more than 20 to 30 ft, unless they reached a sandy zone of higher permeability. These zones could permit deeper migration of dissolved substances (058). Diffusion (the natural force acting to minimize concentration differences) may also disperse the PCB oil in the glacial till pore water.

Because of the limited information available at the time they prepared their report, Mason & Hanger did not recommend any alternatives that depended on the underlying glacial till to contain the more concentrated PCB materials (001). Mason & Hanger recommended additional studies be performed to determine the reliability of the glacial till.

PCBs are heavier than water. The PCBs could gravitate down through the glacial till as evidenced by the PCB penetration into the glacial till immediately adjacent to former OMC discharge points in the Crescent Ditch (001). Penetration of PCBs has occurred at that location with a concentration of 240 ppm found at a depth of about 5 ft into the glacial till (001).

Capping. The use of compacted clay as liners and caps for chemical waste landfills is a well-developed technology. The use of asphaltic concrete as a runoff-accelerating membrane is also well developed. The clay cap could develop cracks due to moisture content variations, settlement, freezing, or other natural phenomena. The asphaltic concrete cap would be used to help reduce the possibility of soil moisture changes, thus reducing the possibility of developing cracks in the clay cap. It is anticipated that the asphaltic concrete membrane would require periodic maintenance to seal cracks that will inevitably develop as the pavement ages.

The impact of cracking of the cap system would be to allow additional surface water to infiltrate the ground, and possibly to permit minor amounts of volatilized PCBs to leave the containment area. If infiltration increased, it could provide hydraulic head inside the contained area that would increase the flow of PCB-contaminated groundwater from inside the contained area to the surrounding or underlying soil. This would result in further PCB contamination of adjacent and underlying soil. The amount of any such uncontrolled release would be expected to be very small. Overall, the reliability of the cap would be considered good.

Permit Requirements

Permit requirements are anticipated to include:

- City of Waukegan construction permits
- Local land use approval
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed of in a currently non-PCB-approved site

See Mason & Hanger's report (003) for further discussion of applicable government regulations.

Alternative 4A: Excavate-Contain-Cap (North Ditch Area Only)

Response Objectives

Under this alternative, a drainage bypass of the North Ditch would be constructed, and soils with PCB contamination in excess of 50 ppm would be excavated from the North Ditch. The Crescent Ditch area would also be excavated to a depth of 3 ft. The soils would be dewatered using well points and pumps. A slurry wall would be constructed around the perimeter of the Crescent Ditch/Oval Lagoon area. This containment wall would extend down to the existing glacial till beneath the local sands (35 ft). Excavated soils from the North

Ditch and Crescent Ditch areas would be placed on top of the Oval Lagoon area. The Crescent Ditch/Oval Lagoon containment area would then be capped with 3 ft of impermeable materials to seal in the contaminated soils.

The slurry wall would minimize uncontrolled dispersion of PCBs from the Crescent Ditch/Oval Lagoon area through the soil or groundwater. Based on Mason & Hanger's equation, if a wall with an overall permeability of 10^{-7} cm/sec were used, migration through a 2-ft slurry wall is expected to take 2 years, dispersing about 0.001 lb/yr PCBs. If the slurry wall were cracked by the fluctuating water table, freezing, or other natural phenomena, PCBs would escape at a much higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the slurry. The State would be required to provide maintenance under PL 96-510.

Using Mason & Hanger's equation (001), migration through a 1-ft-thick layer of glacial till with an overall permeability of 10^{-7} cm/sec would be expected to take 1 year, dispersing about 0.001 lb/yr PCBs. If sandy zones were encountered in the glacial till, PCBs could escape at a higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the glacial till. The State would be required to provide maintenance under PL 96-510.

Capping of the containment area would prevent percolation into the contaminated area. Future construction projects that would cause disturbance to the surface and underlying soils (trenching, drilling, digging, etc.) would not be allowed, to minimize deterioration of the impermeable barriers.

This alternative would reduce the environmental hazards now posed by the PCB contamination in the North Ditch area. Approximately 98 percent of North Ditch soils with PCB contamination in excess of 50 ppm would be removed, and all contaminated soils in the Crescent Ditch/Oval Lagoon area would be contained in-place. The reliability of the slurry wall and capping technologies and the glacial till is discussed in the Reliability Section below.

Containment of the North Ditch in this manner would require a USEPA waiver from the requirements of 40 CFR 761 of TSCA since PCBs would remain in proximity to Lake Michigan and in an area with a high groundwater table (058).

This alternative would have greater land use impacts than Alternatives 1 and 3. The Crescent Ditch area would remain at the existing ground elevation, and would be converted to a parking lot. Future new uses would be restricted because soil-disturbing construction activities could not be allowed.

Landfilling of the Oval Lagoon area with contaminated soil and capping materials would elevate it about 20 to 25 feet above the existing ground level. No future uses of this area would be possible.

Duration of Cleanup Activities

Construction of the drainage bypass and the slurry wall is expected to take about 1 to 2 months. Excavation activities are expected to take a total of 1 to 2 months, and construction of the clay cap and paving another 2 months. If the water treatment plant were not protected against freezing weather, dewatering effluent could not be released to the plant during freezing conditions. Excavation below the water table would then have to take place during nonfreezing weather. The overall duration for this alternative is estimated to be 4 to 6 months.

Impacts and Mitigation of Cleanup Activities

Excavation. Contaminated soils would be excavated from the North Ditch and Crescent Ditch areas by backhoe or front end loader and transported to the Oval Lagoon containment area. Excavation of contaminated soils would also be required for construction of the North Ditch bypass and installation of the well points to control surface and groundwater.

An average volatilization rate that can be expected from exposed sand during excavation activities is 5,375 ug/m²/hr, assuming average PCB concentrations in the exposed sand to be 1,000 ppm. Volatilization that would occur during these activities could be minimized by employing the following mitigation measures:

- Keeping the area exposed by excavation as small as possible.
- Performing the work in as short a time as possible, by using more or larger equipment.
- Covering the exposed material not at the working face with organic materials (such as digested activated sludge, manure, paper mill sludge) or with synthetic liners.
- Performing the work in the winter, since the rate of volatilization during cold weather is less than during warm weather.

The highest reported concentration in the North Ditch soils is about 100,000 ppm (001). The predicted PCB concentration in air during excavation would be about 200 ug/m³. The volatilization rate is predicted to be about 163,000 ug/m²/hr.

Typical concentrations range from 500 to 5,000 ppm. Predicted average PCB concentrations in the air would be less than 6.6 ug/m^3. The average volatilization rate is expected to be less than 5,375 $ug/m^3/hr$ for soils with concentrations of 1,000 ppm PCBs. These values were extrapolated from data for sand, assuming a 3.6-mph wind and an air temperature of 68°F (007). The volatilization rates from the sandy soils of the North Ditch area are expected to be closely approximated by these predictions. By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m^3 in the air at any time. NIOSH recommends that workers not be exposed to more than 1 ug/m^3 in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

Animals could be disturbed or affected by construction activities that would alter or remove their habitats and affect their normal daily and seasonal activities. However, such changes would be expected to affect relatively few species and individuals and would be far outweighed by the benefits to be gained from removal of the contaminated material. Shorebirds, gulls, and possibly other species could be attracted to the excavated areas (048).

Water Treatment. The groundwater removed by pumping from the well points would be fully contained and processed through a package water treatment plant. Secondary solids discharged from the water treatment plant would be treated with other area solids. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct the water quality analyses. Effluent would be discharged into Lake Michigan or a sanitary sewer. Water discharged to the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Backfill of Excavated Areas. The backfill of excavated areas would require soils removal from an offsite borrow pit, causing topographic and other minor local impacts to the borrow area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, excavation, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Reliability

Excavation. Excavation would be accomplished using backhoes and front end loaders. Conventionally available devices based on well-developed technology are feasible for the proposed use. Failure could occur by loss of material during excavation as a result of power loss, accident, or spilling. Where material falls back into the working excavation, there would be essentially no impacts. The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more points on the site. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Slurry Walls. Slurry walls are a relatively new construction technique, in general use for about 20 years. The technology of construction is well developed, but long-term performance data on the use of slurry walls as a seepage cutoff are not available. While it is generally expected that slurry walls would be relatively impervious, it is possible that "windows" of more permeable material could develop during slurry wall construction. Trench backfill is done below the surface of the slurry, so that visual inspection of the backfill as it reaches its final position is not possible. In addition, the upper part of the completed slurry wall could be cracked by freezing, groundwater fluctuations, or other natural phenomena. The literature on the effect of PCBs on slurry wall permeability is limited. It is anticipated that there would be no significant effects, since clay is generally accepted as a liner for licensed PCB disposal sites. However, the types of slurry wall available should be reviewed during design. If the slurry wall failed to achieve the overall average permeability desired, movement of PCB-contaminated groundwater could occur more rapidly than anticipated. On the other hand, slurry walls have been used for groundwater control on many projects and have a good performance record. The containment area would be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment could be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry and cap wall below the frostline.
- Use of a flexible membrane for the cap could be considered for more freedom in site grading.
- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination of the Waukegan area and Lake Michigan. The type of slurry wall material should also be evaluated during design. Overall, the reliability of slurry walls to reduce the movement of PCB-contaminated groundwater is considered good.

Glacial Till. The glacial till covering the bedrock in the Waukegan area is unsorted, glacier-deposited sediment, consisting of silt, clay, and lenses of sand, in which pebbles, cobbles, and boulders are embedded. The thickness of the glacial till typically ranges from 50 to more than 100 ft.

Because of the relatively low permeability of the glacial till, dissolved substances would be unlikely to migrate more than 20 to 30 ft, unless they reached a sandy zone of higher permeability. These zones could permit deeper migration of dissolved substances (058). Diffusion (the natural force acting to minimize concentration differences) may also disperse the PCB oil in the glacial till pore water.

Because of the limited information available at the time they prepared their report, Mason & Hanger did not recommend any alternatives that depended on the underlying glacial till to contain the more concentrated PCB materials (001). Mason & Hanger recommended additional studies be performed to determine the reliability of the glacial till.

PCBs are heavier than water. The PCBs could gravitate down through the glacial till as evidenced by the PCB penetration into the glacial till immediately adjacent to former OMC discharge points in the Crescent Ditch (001). Penetration of PCBs has occurred at that location with a concentration of 240 ppm found at a depth of about 5 ft into the glacial till (001).

Capping. The use of compacted clay as liners and caps for chemical waste landfills is a well-developed technology. The use of asphaltic concrete as a runoff-accelerating membrane is also well developed. The clay cap could develop cracks due to moisture content variations, settlement, freezing, or other natural phenomena. The asphaltic concrete cap would be used to help reduce the possibility of soil moisture changes, thus reducing the possibility of developing cracks in the clay cap. It is anticipated that the asphaltic concrete membrane would require periodic maintenance to seal cracks that will inevitably develop as the pavement ages.

The impact of cracking of the cap system would be to allow additional surface water to infiltrate the ground, and possibly to permit minor amounts of volatilized PCBs to leave the containment area. If infiltration increased, it could provide hydraulic head inside the contained area that would increase the flow of PCB-contaminated groundwater from inside the contained area to the surrounding or underlying soil. This would result in further PCB contamination of adjacent and underlying soil. The amount of any such uncontrolled release would be expected to be very small. Overall, the reliability of the cap would be considered good.

Permit Requirements

Permit requirements are anticipated to include:

- Well water removal permit (State)
- IEPA permit for construction of wastewater treatment facilities
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- City of Waukegan construction permits
- Local land use approval
- IEPA (Division of Land and Noise) special waste hauler's permit
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site
- Certification of Authority to haul PCB commodities (ICC and IICC)

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

Alternative 4B: Excavate-Contain Part of E-W Portion of the North Ditch-Cap (North Ditch Area Only)

Response Objectives

Under this alternative, the east-west portion of the North Ditch would be excavated only to the extent necessary to install a pipeline bypass within the ditch area. This would require excavation to a depth of 10 ft and a width of 7 ft, removing approximately 5,500 yd^3 of soil. In comparison, excavation under the other North Ditch alternatives would be to a depth of 15 ft and a width of 25 ft, removing approximately 25,000 yd^3 of soil. Construction of a structural support system (sheet piling) would not be necessary under this alternative because of the limited excavation involved.

The soil, however, would be dewatered using well points and pumps before excavation. After the bypass is installed, the excavated area would be backfilled and capped with impermeable materials.

The Crescent Ditch area would be excavated to a depth of 3 ft. All excavated soils would be dewatered using well points and pumps. A slurry wall would be constructed around the perimeter of the Crescent Ditch/Oval Lagoon area. This containment wall would extend down to the existing glacial till beneath the local sands (35 ft). Excavated soils from the North Ditch and Crescent Ditch areas would be placed on top of the Oval Lagoon area. The Crescent Ditch/Oval Lagoon containment area would then be capped with 3 ft of impermeable materials to seal in the contaminated soils.

The slurry wall would minimize uncontrolled dispersion of PCBs from the Crescent Ditch/Oval Lagoon area through the soil or groundwater. Using Mason & Hanger's equation for dispersion of PCBs (001), if a wall with an overall permeability of 10^{-7}cm/sec were used, migration through a 2-ft slurry wall is expected to take 2 years, dispersing about 0.001 lb/yr PCBs. If the slurry wall were cracked by the fluctuating water table, freezing, or other natural phenomena, PCBs would escape at a much higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the slurry. The State would be required to provide maintenance under PL 96-510.

Using Mason & Hanger's equation (001), migration through a 1-ft-thick layer of glacial till with an overall permeability of 10^{-7} cm/sec would be expected to take 1 year, dispersing about 0.001 lb/yr PCBs. If sandy zones were encountered in the glacial till, PCBs could escape at a higher rate. Groundwater monitoring wells would be constructed to provide continuous checks on the efficiency of the glacial till. The State would be required to provide maintenance under PL 96-510.

Capping of the North Ditch and the containment area would prevent percolation into the contaminated area. Future construction projects that would cause disturbance to the surface and underlying soils (trenching, drilling, digging, etc.) would not be allowed, to minimize deterioration of the impermeable barriers.

This alternative would reduce the environmental hazards now posed by the PCB contamination in the North Ditch area. Contaminated soils in the Crescent Ditch/Oval Lagoon area would be contained in-place; the reliability of the slurry wall and capping technologies and the glacial till is discussed in the Reliability section, below. Approximately 19,400 yd^3 of soil containing about 3,400 lb of PCBs would not be removed from the North Ditch. The hydrologic system is currently not well enough understood to determine the extent of past or future PCB contamination by groundwater movement from the North Ditch. However, the potential for future groundwater contamination would be higher under this alternative than under the other North Ditch alternatives because of the remaining contaminated soils. While capping would prevent direct percolation into the contaminated area, some dispersion of PCBs through the groundwater could occur because no containment wall would be present (080). However, the PCBs represent less than 1 percent of all the PCBs now found in the North Ditch/Parking Lot area.

This alternative would not remove approximately 19,400 yd^3 of soil containing approximately 3,400 lb of PCBs in the North Ditch area.

This alternative would have greater land use impacts than Alternatives 1 and 3. The Crescent Ditch area would remain at the existing ground elevation, and would be converted to a parking lot. Future new uses would be restricted because soil-disturbing construction activities could not be allowed. Landfilling of the Oval Lagoon area with contaminated soil and capping materials would elevate it about 10 feet above the existing ground level. No future uses of this area would be possible.

Duration of Cleanup Activities

Construction of the drainage bypass is expected to take about 1 to 2 months. Excavation activities are expected to take a total of 1 to 2 months, and construction of the clay cap and paving another 2 months. If the water treatment plant were not protected against freezing weather, dewatering effluent could not be released to the plant during freezing conditions. Excavation below the water table would then have to take place during nonfreezing weather. The overall duration for this alternative is estimated to be 4 to 6 months.

Impacts and Mitigation of Cleanup Activities

Excavation. Contaminated soils would be excavated from the North Ditch and Crescent Ditch areas by backhoe or front end loader and transported to the Oval Lagoon containment area. Excavation of contaminated soils would also be required for construction of the North Ditch bypass and installation of the well points to control surface and groundwater.

An average volatilization rate that can be expected from exposed sand during excavation activities is 5,375 $ug/m^2/hr$, assuming average PCB concentrations in the exposed sand to be 1,000 ppm. Volatilization that would occur during these activities could be minimized by employing the following mitigation measures:

- Keeping the area exposed by excavation as small as possible.
- Performing the work in as short a time as possible, by using more or larger equipment.
- Covering the exposed material not at the working face with organic materials (such as digested activated sludge, manure, paper mill sludge) or with synthetic liners.
- Performing the work in the winter, since the rate of volatilization during cold weather is less than during warm weather.

The highest reported concentration in the North Ditch soils is about 100,000 ppm (001). The predicted PCB concentration in air during excavation would be about 200 ug/m³. The volatilization rate is predicted to be about 163,000 ug/m²/hr. Typical concentrations range from 500 to 5,000 ppm. Predicted average PCB concentrations in the air would be less than 6.6 ug/m³. The average volatilization rate is expected to be less than 5,375 ug/m²/hr for soils with concentrations of 1,000 ppm PCBs. These values were extrapolated from data for sand, assuming a 3.6-mph wind and an air temperature of 68°F (007). The volatilization rates from the sandy soils of the North Ditch area are expected to be closely approximated by these predictions. By comparison, the OSHA standard for maximum worker exposure to Aroclor 1242 is 1,000 ug/m³ in the air at any time. NIOSH recommends that workers not be exposed to more than 1 ug/m³ in the air during an 8-hour period (007). (See Health and Safety Requirements, later in this section.)

Animals could be disturbed or affected by construction activities that would alter or remove their habitats and affect their normal daily and seasonal activities. However, such changes would be expected to affect relatively few species and individuals and would be far outweighed by the benefits to be gained from removal of the contaminated material. Shorebirds, gulls, and possibly other species could be attracted to the excavated areas (048).

Water Treatment. The groundwater removed by pumping from the well points would be fully contained and processed through a package water treatment plant. Secondary solids discharged from the water treatment plant would be treated with other area solids. All water would be treated to PCB levels of below 1 ppb (the USEPA standard). Treatment plant effluent would be monitored (by grab sampling and 24-hour sampling) to ensure that discharges were below 1 ppb. An onsite laboratory would be available to conduct the water quality analyses. Effluent would be discharged into Lake Michigan or a sanitary sewer. Water discharged to the sanitary sewer system would be processed again through the Waukegan municipal wastewater treatment plant and discharged into the Des Plaines River.

Backfill of Excavated Areas. The backfill of excavated areas would require soils removal from an offsite borrow pit, causing topographic and other minor local impacts to the borrow area.

Additional Environmental Impacts. Implementation of this alternative would also have the following impacts (048):

Noise. Noise would be produced by construction, excavation, and transportation activities. Although high noise levels could periodically occur in localized areas, they would be of relatively short duration. Noise impacts could temporarily diminish people's enjoyment of the public beach adjacent to the project area.

Employment. Construction jobs created by the project would temporarily reduce unemployment in the area. Employment levels would return to previous levels at the conclusion of the project.

Cultural Resources. Cultural resources in the Waukegan Harbor area would not be adversely affected. It is possible that the cleanup of PCB-contaminated sediments would enhance the desirability of acquiring and retaining cultural resources in the harbor area.

Health and Safety Requirements. The PCB-contaminated soil, sediment, muck, dust, and water associated with cleanup activities present potentially significant health hazards to workers involved in the cleanup. Each specific cleanup activity and associated work function would require the definition and enforcement of specific safety precautions and levels of protection. Ecology and Environment, Inc., has prepared a conceptual safety plan (Appendix). The plan calls for protection measures for workers who may be exposed to PCB-contaminated materials. Ambient air monitoring would be performed, and all workers would require appropriate levels of protection. Depending on ambient air monitoring results, respiratory and dermal protection may be required downwind of site cleanup activities. In addition to personal protection, the conceptual safety plan specifies site entry procedures, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan would be prepared during final design of the selected response measures.

Reliability

Excavation. Excavation would be accomplished using backhoes and front end loaders. Conventionally available devices based on well-developed technology are feasible for the proposed use. Failure could occur by loss of material during excavation as a result of power loss, accident, or spilling. Where material falls back into the working excavation, there would be essentially no impacts. The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more points on the site. The impact of such spills could be minimized by prompt cleanup of the spilled material and of any soil or other material that was contaminated by the spill.

Water Treatment. The water treatment system would use existing technology and equipment shown to be effective in PCB removal. The treatment plant would include a clearwell for detention of treated effluent prior to discharge. PCB concentrations in the clearwell would be monitored, and if adequate removal were not achieved, the water could be recycled through the plant until discharge standards (less than 1 ppb PCBs) were met.

Slurry Walls. Slurry walls are a relatively new construction technique, in general use for about 20 years. The technology of construction is well developed, but long-term performance data on the use of slurry walls as a seepage cutoff are not available. While it is generally expected that slurry walls would be relatively impervious, it is possible that "windows" of more permeable material could develop during slurry wall construction. Trench backfill is done below the surface of the slurry, so that visual inspection of the backfill as it reaches its final position is not possible. In addition, the upper part of the completed slurry wall could be cracked by freezing, groundwater fluctuations, or other natural phenomena. The literature on the effect of PCBs on slurry wall permeability is limited. It is anticipated that there would be no significant effects, since clay is generally accepted as a liner for licensed PCB disposal sites. However, the types of slurry wall available should be reviewed during design. If the slurry wall failed to achieve the overall average permeability desired, movement of PCB-contaminated groundwater could occur more rapidly than anticipated. On the other hand, slurry walls have been used for groundwater control on many projects and have a good performance record. The containment area would be monitored to permit ongoing evaluation of the effectiveness and integrity of the slurry walls and clay cap. The reliability of the containment could be enhanced with development of additional design details:

- Freeze-thaw problems could be reduced by terminating the slurry and cap wall below the frostline.

- Use of a flexible membrane for the cap could be considered for more freedom in site grading.

- Should contaminant movement be detected, an internal drainage system could be installed to maintain internal water levels lower than external levels so that any leakage would be into the containment area.

Consideration of these types of details during design would make this alternative effective in abating further PCB contamination of the Waukegan area and Lake Michigan. The type of slurry wall material should also be evaluated during design. Overall, the reliability of slurry walls to reduce the movement of PCB-contaminated groundwater is considered good.

Glacial Till. The glacial till covering the bedrock in the Waukegan area is unsorted, glacier-deposited sediment, consisting of silt, clay, and lenses of sand, in which pebbles, cobbles, and boulders are embedded. The thickness of the glacial till typically ranges from 50 to more than 100 ft.

Because of the relatively low permeability of the glacial till, dissolved substances would be unlikely to migrate more than 20 to 30 ft, unless they reached a sandy zone of higher permeability. These zones could permit deeper migration of dissolved substances (058). Diffusion (the natural force acting to minimize concentration differences) may also disperse the PCB oil in the glacial till pore water.

Because of the limited information available at the time they prepared their report, Mason & Hanger did not recommend any alternatives that depended on the underlying glacial till to contain the more concentrated PCB materials (001). Mason & Hanger recommended additional studies be performed to determine the reliability of the glacial till.

PCBs are heavier than water. The PCBs could gravitate down through the glacial till as evidenced by the PCB penetration into the glacial till immediately adjacent to former OMC discharge points in the Crescent Ditch (001). Penetration of PCBs has occurred at that location with a concentration of 240 ppm found at a depth of about 5 ft into the glacial till (001).

Capping. The use of compacted clay as liners and caps for chemical waste landfills is a well-developed technology.

The use of asphaltic concrete as a runoff-accelerating membrane is also well developed. The clay cap could develop cracks due to moisture content variations, settlement, freezing, or other natural phenomena. The asphaltic concrete cap would be used to help reduce the possibility of soil moisture changes, thus reducing the possibility of developing cracks in the clay cap. It is anticipated that the asphaltic concrete membrane would require periodic maintenance to seal cracks that will inevitably develop as the pavement ages.

The impact of cracking of the cap system would be to allow additional surface water to infiltrate the ground, and possibly to permit minor amounts of volatilized PCBs to leave the containment area. If infiltration increased, it could provide hydraulic head inside the contained area that would increase the flow of PCB-contaminated groundwater from inside the contained area to the surrounding or underlying soil. This would result in further PCB contamination of adjacent and underlying soil. The amount of any such uncontrolled release would be expected to be very small. Overall, the reliability of the cap would be considered good.

Permit Requirements

Permit requirements are anticipated to include:

- Well water removal permit (State)
- IEPA permit for construction of wastewater treatment facilities
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- City of Waukegan construction permits
- Local land use approval
- IEPA (Division of Land and Noise) special waste hauler's permit
- USEPA toxic substances disposal approval

- IEPA approval if material is disposed in a currently non-PCB-approved site

- Certification of Authority to haul PCB commodities (ICC and IlCC)

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

Subalternative I: Select Excavation

Response Objectives

This subalternative would be used only in conjunction with Alternative 4A and 4B. The most highly contaminated areas in the Crescent Ditch/Oval Lagoon area would be excavated and disposed of offsite. Excavation, containment, onsite disposal, and capping for the rest of the North Ditch area would occur as described under Alternative 4A or 4B.

Because soils with the greatest PCB concentrations would be removed (about 440,500 lb of PCBs in 5,500 yd^3 of soils), this variation would reduce the impacts of possible PCB migration or escape through the slurry wall and the glacial till. The reliability of the slurry wall and capping technologies and the glacial till is discussed in the Reliability Sections of Alternatives 4A and 4B. Subalternative I would remove and dispose of offsite approximately 57 percent of all the PCBs now found in the North Ditch/Parking Lot area.

With this subalternative, the Oval Lagoon area would be landfilled and capped to about 10 to 15 ft above the existing ground level.

Duration of Cleanup Activities

The excavation and offsite disposal of the highly contaminated "hot spots" would add about 1 month to the cleanup activities of Alternative 4A or 4B. Total project duration with this variation is therefore estimated to be 5 to 7 months.

Impacts and Mitigation of Cleanup Activities

Excavation. The highly contaminated soils have PCB concentrations greater than 100,000 ppm (001). Volatilization during excavation and loading of these soils is estimated to be in the range of 163,000 $ug/m^2/hr$. Concentration in the air above the most contaminated soils is estimated to be about 200 ug/m^3.

Solids Removal and Disposal. Excavated soil would be transported by truck to an offsite disposal site. The trucks would have to be lined to prevent leakage. Cover or closure of the trucks would prevent spillage and volatilization during transport. Rules and regulations controlling the transport of toxic materials promulgated by the USDOT, USEPA, IDOT, IINR, and other applicable regulatory agencies would be complied with. These include cleanup, safety, and spill prevention and response measures.

Offsite disposal of excavated soil would require approximately 550 truck trips to the disposal site using a 10-yd³ capacity truck. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic, but some roadway congestion and roadway damage could occur (048). Some species of terrestrial animals could come into contact with contaminated materials if any loss occurs during transport, and the contamination could be passed into other terrestrial food chains (048).

Disposal of the excavated soil would be in a licensed chemical waste landfill, and would be in compliance with State and Federal standards for PCB waste disposal. PCB materials with concentrations greater than 50 ppm must be nonflowable if they are to be disposed of in a chemical waste landfill (40 CFR 761). This alternative assumes that the contaminated soils can be excavated in a nonflowable state, since they are mostly sand.

Reliability

Glacial Till. The glacial till covering the bedrock in the Waukegan area is unsorted, glacier-deposited sediment, consisting of silt, clay, and lenses of sand, in which pebbles, cobbles, and boulders are embedded. The thickness of the glacial till typically ranges from 50 to more than 100 ft.

Because of the relatively low permeability of the glacial till, dissolved substances would be unlikely to migrate more than 20 to 30 ft, unless they reached a sandy zone of higher permeability. These zones could permit deeper migration of dissolved substances (058). Diffusion (the natural force acting to minimize concentration differences) may also disperse dissolved PCBs in the glacial till pore water.

Because of the limited information available at the time they prepared their report, Mason & Hanger did not recommend any alternatives that depended on the underlying glacial till to contain the more concentrated PCB materials (001). Mason & Hanger recommended additional studies be performed to determine the reliability of the glacial till.

Section 7
ALTERNATIVES SUGGESTED FOR PUBLIC COMMENT

The preliminary, initial, and detailed development and evaluation of alternatives were presented in the previous sections of this report. The development and evaluation process was used to determine the remedial action alternative for each area that was cost-effective (i.e., "the lowest cost alternative that is technologically feasible and reliable and which effectively mitigates and minimizes damage to and provides adequate protection of public health, welfare, or the environment"--Section 300.68(j) of the NCP).

The alternatives that were retained from the screening processes of Tasks 1 through 3 to the detailed evaluation of Task 5 were considered technologically feasible and reliable and would effectively mitigate and minimize damage to, and provide adequate protection of, public health, welfare, and the environment. The economic evaluation (Section 5) defined the alternatives with the least cost. A summary of the detailed cost estimates and the pounds of PCBs controlled is presented in Tables 7-1 and 7-2. The cumulative project costs versus the cumulative pounds of PCBs controlled are shown on Figure 7-1.

The relative advantages and disadvantages of each alternative are presented in Tables 7-3 through 7-6. Alternatives for each area were ranked together (e.g., Slip No. 3 Alternatives, etc.). The relative ranking of (0) was used as the base value. If one alternative was more favorable than another, it was assigned a relative ranking of (+). Less favorable alternatives were assigned the relative ranking of (-).

Section 104(c)(4) of CERCLA requires that the need for protection of the public health and welfare and the environment at the OMC site be balanced against the amount of money available in the fund to respond to other sites, which also present a threat to public health and welfare and the environment. Accordingly, the lead agency must consider the need to respond to other releases in determining the appropriate extent of remedy for fund-financed response at the OMC site.

Based on this feasibility study, the five cleanup actions listed below comprise USEPA's recommended cleanup plan for the OMC site.

- <u>Slip No. 3 and Upper Harbor: Subalternative I</u>. This subalternative would be used only in conjunction with Alternative 6B, PCB-contaminated sediment, sand, and silt would be dredged from the localized area near the former OMC outfall. This material contains the greatest PCB concentrations in the harbor and represents 92 percent of all the PCBs now found in Slip No. 3 and the Upper Harbor. This alternative

Table 7-1

SUMMARY TABLE
DETAILED COST ESTIMATE AND POUNDS OF PCBS CONTROLLED
SLIP NO. 3 AND UPPER HARBOR
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Alternative	Slip No. 3			Upper Harbor		
	Costs	Pounds Controlled	Cost Per Pound	Costs	Pounds Controlled	Cost Per Pound
2B: Dredge-Dewater in Lagoon-Fix-Dispose	$10,740,000	290,000	$37.00	$24,830,000	4,800	$5,172.90
2D: Dredge-Dewater in Barges-Fix-Dispose	9,580,000	290,000	33.00	N/A[a]	N/A	N/A
3: Dredge-Dewater in Lagoon-Dispose	7,630,000	290,000	26.30	13,690,000	4,800	2,852.10
6A: Contain-Dredge-Cap	9,300,000	310,000	30.00	-[b]	-	-
6B: Contain-Dredge Part of Upper Harbor-Cap	6,100,000	306,900	19.90	-	-	-
6AI: Select Excavation-Contain-Dredge-Cap	12,450,000	310,000	40.20	-	-	-
6BI: Select Excavation-Contain-Dredge Part of Upper Harbor-Cap	9,250,000	306,900	30.10	-	-	-

[a] N/A = not applicable.
[b] Included with Slip No. 3.

FD525.027.1

Table 7-2

SUMMARY TABLE
DETAILED COST ESTIMATE AND POUNDS OF PCBS CONTROLLED
NORTH DITCH/PARKING LOT AREA
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Alternative	North Ditch			Parking Lot Area		
	Costs	Pounds Controlled	Cost Per Pound	Costs	Pounds Controlled	Cost Per Pound
1: Excavate-Dispose	$16,670,000	485,600	$34.30	$12,570,000	272,100	$ 46.20
3: Excavate-Fix-Dispose	26,820,000	485,600	55.20	35,960,000	272,100	132.20
4: Contain-Cap	NA[a]	NA	NA	3,210,000	495,500	6.50
4A: Excavate-Contain-Cap (North Ditch Area Only)	8,720,000	495,400	17.60	NA	NA	NA
4B: Excavate-Contain Part of E-W Portion of the North Ditch-Cap (North Ditch Area Only)	4,210,000	492,000	8.60	N/A	N/A	N/A
4A1: Select Excavation-Excavate-Contain-Cap (North Ditch Area Only)	9,460,000	495,400	19.10	N/A	N/A	N/A
4B1: Select Excavation-Excavate-Contain Part of E-W Portion of the North Ditch-Cap (North Ditch Area Only)	4,950,000	492,000	10.10	N/A	N/A	N/A

[a]N/A = not applicable.

PD525.028.1

Table 7-3

RANKING PROCEDURE
SLIP NO. 3
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

	Ranking Numbers						
	Alternatives						
Criteria	2B	2D	3	6A	6B	6AI	6BI
Capital cost	-	-	-	0	+	0	0
Life cycle cost	-	-	-	0	+	0	0
Long-term environmental impact	+	+	+	-	-	0	-
Short-term environmental impact	-	-	-	0	0	-	-
Implementation time	+	+	-	0	0	0	0
Constructibility	-	-	-	0	0	0	0
Reliability	+	+	+	-	-	0	-
Health risks	0	0	0	0	0	0	0
Safety requirements	-	-	-	0	0	-	-
Land reuse	+	+	+	0	0	0	0
Complexity of operation	-	-	-	0	0	-	-

Note: - is least favorable; + is most favorable.
2B: Dredge-Dewater in Lagoon-Fix-Dispose
2D: Dredge-Dewater in Barges-Fix-Dispose
3: Dredge-Dewater in Lagoon-Dispose
6A: Contain-Dredge-Cap
6B: Contain-Dredge Part of Upper Harbor-Cap
6AI: Select Excavation-Contain-Dredge-Cap
6BI: Select Excavation-Contain-Dredge Part of Upper Harbor-Cap

Table 7-4

RANKING PROCEDURE
UPPER HARBOR
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Criteria	Ranking Numbers					
	Alternatives					
	2B	3	6A	6B	6AI	6BI
Capital cost	-	-	0	+	0	0
Life cycle cost	-	-	0	+	0	0
Long-term environmental impact	+	0	-	-	0	-
Short-term environmental impact	0	+	0	0	-	-
Implementation time	+	-	0	0	0	0
Constructibility	+	+	0	0	0	0
Reliability	+	+	-	-	0	-
Health risks	0	0	0	0	0	0
Safety requirements	0	0	0	0	-	-
Land reuse	+	-	0	0	0	0
Complexity of operation	-	0	0	0	-	-

Note: - is least favorable; + is most favorable.
2B: Dredge-Dewater in Lagoon-Fix-Dispose
3: Dredge-Dewater in Lagoon-Dispose
6A: Contain-Dredge-Cap
6B: Contain-Dredge Part of Upper Harbor-Cap
6AI: Select Excavation-Contain-Dredge-Cap
6BI: Select Excavation-Contain-Dredge Part of Upper Harbor-Cap

Table 7-5

RANKING PROCEDURE
NORTH DITCH
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Criteria	Ranking Numbers					
	Alternatives					
	1	3	4A	4B	4AI	4BI
Capital cost	-	-	+	0	0	0
Life cycle cost	-	-	+	0	0	0
Long-term environmental impact	+	+	-	-	0	-
Short-term environmental impact	-	0	0	0	0	0
Implementation time	+	+	-	-	-	-
Constructibility	0	+	+	+	+	+
Reliability	+	+	-	-	0	-
Health risks	0	0	0	0	0	0
Safety requirements	-	+	0	0	-	-
Land reuse	+	+	0	0	0	0
Complexity of operation	-	+	0	0	0	0

Note: - is least favorable; + is most favorable.
1: Excavate-Dispose
3: Excavate-Fix-Dispose
4A: Excavate-Contain-Cap
4B: Excavate-Contain Part of E-W Portion of the North Ditch-Cap
4AI: Select Excavation-Excavate-Contain-Cap
4BI: Select Excavation-Excavate-Contain Part of E-W Portion of the North Ditch-Cap

Table 7-6

RANKING PROCEDURE
PARKING LOT
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS
13-5M28.0

Criteria	Ranking Numbers Alternatives 1	3	4
Capital cost	-	-	+
Life cycle cost	-	-	+
Long-term environmental impact	+	+	0
Short-term environmental impact	-	-	+
Implementation time	+	+	-
Constructibility	0	0	+
Reliability	+	+	0
Health risks	0	0	0
Safety requirements	-	-	0
Land reuse	+	+	0
Complexity of operation	-	-	0

Note: - is least favorable; + is most favorable.
1: Excavate-Dispose
3: Excavate-Fix-Dispose
4: Contain-Cap

would remove, fix, and dispose of an estimated 5,700 yd^3 of PCB-contaminated material containing about 286,500 lb of PCBs. The material would be disposed of offsite in a licensed chemical waste landfill. The estimated Order-of-Magnitude cost is $3,150,000.

- <u>Slip No. 3 and Upper Harbor: Alternative 6B</u>. A cofferdam with a slurry wall would be constructed around the perimeter of Slip No. 3, part of the Upper Harbor sediments would be dredged into the contained area, and then the containment area would be capped. The estimated Order-of-Magnitude cost is $6,100,000.

  The emerging technology, such as the Pollution Sciences extraction or bacterial destruction technique, should be reevaluated before placement of the cap to determine their cost effectiveness.

- <u>North Ditch Area: Subalternative I</u>. This subalternative would be used only in conjunction with Alternative 4B. PCB-contaminated soil would be excavated from the localized areas in the Crescent Ditch and Oval Lagoon. This material contains the greatest PCB concentrations in the North Ditch area and represents 57 percent of all the PCBs now found in the North Ditch/Parking Lot area. This alternative would remove and dispose of an estimated 5,500 yd^3 of PCB-contaminated soil containing about 440,500 lb of PCBs. The soil would be disposed of offsite in a licensed chemical waste landfill. The estimated Order-of-Magnitude cost is $740,000.

- <u>North Ditch Area: Alternative 4B</u>. PCB-contaminated soil would be contained and capped in the Crescent Ditch/Oval Lagoon area. A pipeline to bypass the east-west portion of the North Ditch would also be constructed (with partial excavation of PCB-contaminated soil to install the pipe). The PCB-contaminated soil from the bypass excavation would be placed in the Crescent Ditch/Oval Lagoon area before capping the area. The estimated Order-of-Magnitude cost is $4,210,000.

- <u>Parking Lot Area: Alternative 4</u>. PCB-contaminated soil would be contained and capped in the Parking Lot area. The estimated Order-of-Magnitude cost is $3,210,000.

The total estimated Order-of-Magnitude cost to implement the above alternatives is $17,410,000.

Public comments will be received during the 30-day public comment period. The USEPA Record of Decision issued at the end of the public comment period will determine specifically the alternatives to be implemented, with modifications, if any, resulting from public comment.

A conceptual design will be prepared for the remedial action alternative(s) selected by USEPA.

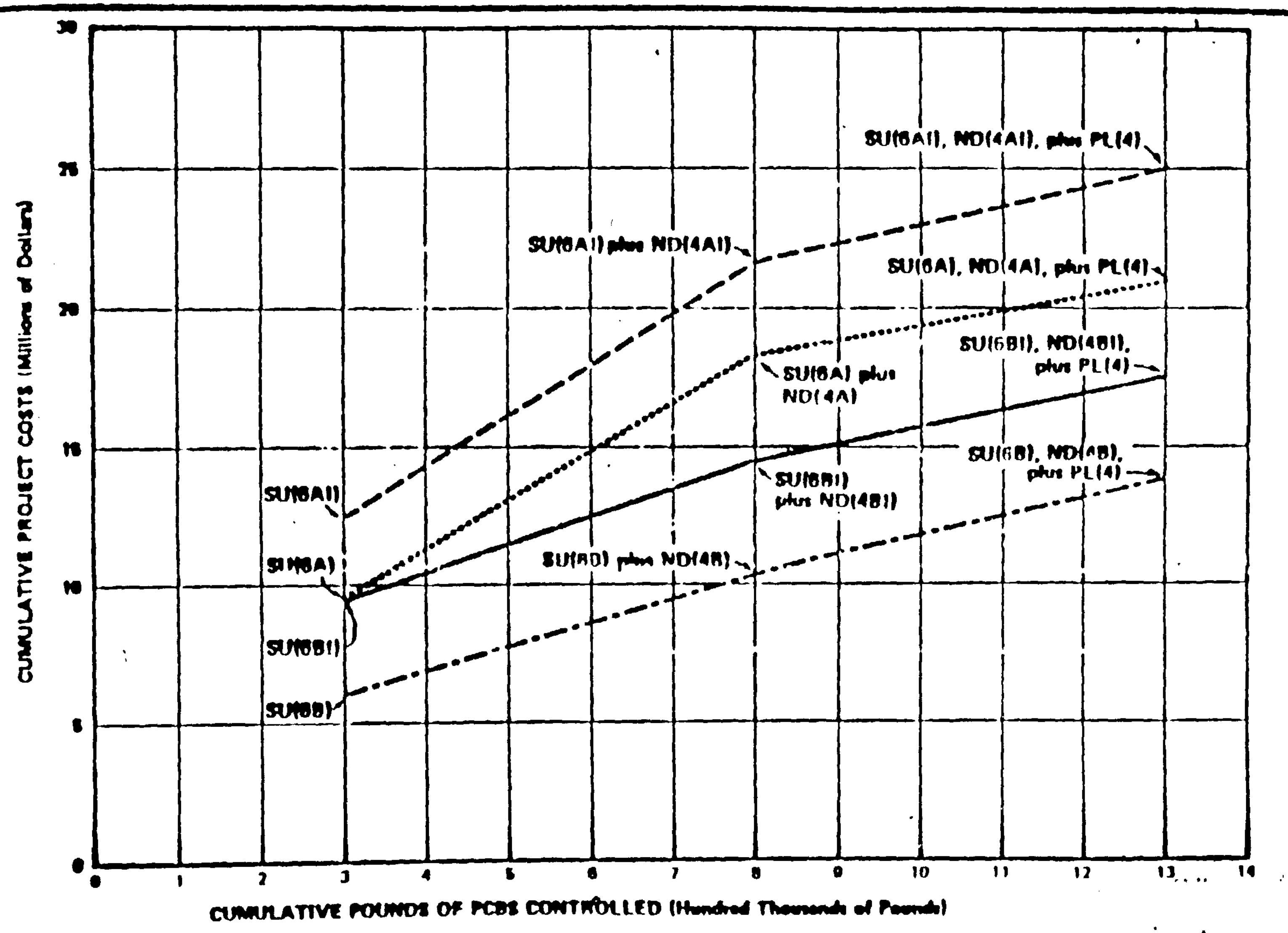
The following individuals participated in the preparation of this feasibility study:

<u>U.S. Environmental Protection Agency</u>

Mr. Jack Braun
Environmental Scientist
U.S. EPA/Remedial Response
Section 2 5HR-13th Floor
230 S. Dearborn
Chicago, Illinois 60604
(312) 886-6214

<u>CH2M HILL</u>

Mr. Stewart L. Davis
Project Manager
CH2M HILL
2020 S.W. Fourth Avenue
Portland, Oregon 97201
(503) 224-9190



SU(XX) Slip No. 3 and Upper Harbor
ND(XX) North Ditch
PL(XX) Parking Lot

NOTE: (XX) Refers to Alternative Number.

FIGURE 7-1
CUMULATIVE PROJECT COSTS VERSUS CUMULATIVE POUNDS OF PCBS CONTROLLED
OMC HAZARDOUS WASTE SITE
WAUKEGAN, ILLINOIS

CH2M HILL

W68330.00

PCBs are heavier than water. The PCBs could gravitate down through the glacial till as evidenced by the PCB penetration into the glacial till immediately adjacent to former OMC discharge points in the Crescent Ditch (001). Penetration of PCBs has occurred at that location with a concentration of 240 ppm PCB found at a depth of 4 ft 9 in into the glacial till (001).

Removing the very high concentrations of PCBs near the OMC outfalls would remove the area where the PCBs have been known to migrate into the glacial till.

Transportation. Transportation would be accomplished using dump trucks. Failure could occur by loss of material from the truck through leakage, spilling over the top, dusting, volatilization, or spills resulting from vehicle accidents.

The impact of leakage, dusting, and volatilization would be to dispense small amounts of PCBs all along the haul routes. These types of uncontrolled release could be minimized by the use of tailgate seals and covers.

The impact of spills would be to deposit a quantity of PCB-contaminated solids at one or more isolated points. The risk of spills over the top of the truck could be minimized by use of a cover. The risk of vehicle accidents is relatively small, but it could be compensated for by having a response plan and team ready during hauling.

Permit Requirements

Permit requirements are anticipated to include:

- Well water removal permit (State)
- IEPA permit for construction of wastewater treatment facilities
- USCOE Section 404 (disposal in waterways) permit
- IEPA water quality certification on all USCOE permits
- NPDES permit (State/Federal) for point-source water discharge from the water treatment plant
- North Shore Sanitary District approval if water discharge goes to a sanitary sewer
- IEPA (Division of Land and Noise) special waste hauler's permit
- City of Waukegan construction permits

- Local land use approval
- Certification of Authority to haul PCB commodities (ICC and IlCC).
- USEPA toxic substances disposal approval
- IEPA approval if material is disposed in a currently non-PCB-approved site

See Mason & Hanger's report (003) for further discussion of applicable governmental regulations.

Appendix
CONCEPTUAL SITE HEALTH AND SAFETY PLAN

INTRODUCTION

The conceptual site health and safety plan is intended to outline, in general terms, the various requirements to allow remedial site activities at the OMC site in Waukegah, Illinois. Remedial site activities may include cleanup activities such as hydraulic and/or mechanical dredging, excavation and dewatering of soil, trenching, and waste hauling via trucks and/or barges.

The waste characteristics include liquid, solid, and sludge materials of a toxic nature. PCBs from hydraulic fluids used in an aluminum die-casting facility are the source of the wastes that have contaminated Waukegan Harbor and the North Ditch/Parking Lot areas.

HAZARD EVALUATION

The cleanup activities may include hydraulic, pneumatic, and/or mechanical dredging of harbor sediments including those in Slip No. 3; dewatering and subsequent excavation of soils of the North Ditch; and excavation of contaminated soils from the Parking Lot area. The last two items will require the collection and diversion of stormwater runoff. Dewatering may involve the construction of a dewatering lagoon.

The health hazards associated with the above cleanup activities are both chemical and physical in nature and include: respiratory and dermal hazards, noise, and hazards associated with the construction, excavation, and trenching.

Volatilization of PCBs and increased dust levels containing PCBs during dredging and excavation operations will temporarily increase PCB concentrations in the air. These levels may exceed the OSHA standards and NIOSH recommendations of 1.0 mg/m^3 and 1.0 ug/m^3, respectively. Both volatilized PCBs and PCB-laden dust, as well as high PCB concentrations in the excavated materials (soil, sludge, and water) will require dermal protection. Noise and other physical hazards will be produced by construction activities. Both State and Federal OSHA safety and health standards that apply to the construction industry (such as 29 CFR 1926/1910) must be enforced.

As stated above, the OSHA permissible exposure limit is 1.0 mg/m^3. The NIOSH recommended level is 1.0 ug/m^3 for a 10-hour time-weighted average, due to PCB designation as a suspected carcinogen. The immediately dangerous to life or health concentration is 5 mg/m^3.

PCBs are colorless to dark brown liquids that possess a mild hydrocarbon odor. However, this compound will most likely be bound to the soil and sediment components of Waukegan Harbor and surrounding OMC facility areas and environment.

The major routes of entry into the body are inhalation, ingestion, and skin or eye contact. The target organs are the skin, eyes, liver, and kidneys. Major symptoms of PCB exposure include eye irritation, dermatitis (notably chloracne), hepatic degeneration, fatigue, dark urine, and jaundice.

General first aid procedures include:

- If PCBs get into the eyes, immediately wash the eyes for at least 15 minutes with copious amounts of water, occasionally lifting the lower and upper lids. Medical attention should be sought immediately. Contact lenses are not to be worn by personnel during any onsite activities.

- Any contact with the skin will require the prompt washing of the contaminated areas with soap or mild detergent and water. If liquids or soils potentially contaminated with PCBs penetrate through clothing, the clothing should be immediately removed and the skin should be washed as described above. Any signs of skin irritation warrant prompt medical attention.

- If a worker breaths in significant amounts of PCB-contaminated air, the exposed individual should be moved to an uncontaminated area at once. Medical attention should be sought promptly. If breathing has stopped, artificial respiration should be performed.

- If ingested, seek medical attention immediately, induce vomiting with syrup of Ipecac or physical means. Do not make an unconscious person vomit.

Those personnel who will come into direct contact with PCB-contaminated soils, sludges, and liquids are at the greatest risk and must be protected and monitored accordingly. Those personnel who will work close to defined PCB-contaminated areas, (i.e., heavy equipment operators) will also be at high risk and must be properly protected and monitored.

The greatest potential health hazards within the project area are as follows:

-

- The massive amount of contaminated sediment dredged from Slip No. 3 and associated dusts

- The contaminated sediments, sands, and clays near the abandoned OMC outfalls

- The contaminated soils of the Crescent Ditch and Oval Lagoon located on the western end of the North Ditch

- The contaminated soil areas designated as "hot spots" located in the parking lot

- The contaminated water and dredged soils in and around the dewatering basins, if used, and general construction and dredging activities onsite

The variously contaminated soils, sediments, mucks, dusts, and water adjacent to and associated with the aforementioned areas and activities present potentially significant health hazards to the personnel involved in this cleanup. Therefore, all personnel who will come into direct contact with these contaminated materials must be provided with the maximum allowable protection including self-contained breathing apparatus (SCBA) and sufficient dermal protection. Personnel monitoring and subsequent analysis will be required in order to document a lowering of this protection level. Dependent upon ambient air monitoring results, specific respiratory and dermal protection may be required downwind of any site cleanup activities and holding basins.

Each specific cleanup activity and associated work function will require the definition and enforcement of specific safety precautions and levels of protection. This conceptual safety plan will require updating as the final abatement alternatives are better defined. Once work has begun onsite, daily safety meetings are to be held so as to specifically define individual work responsibilities in relation to recognized hazard potentials. Therefore, various modifications to the site safety plan may be required.

SITE SAFETY WORK PLAN

The site perimeter shall be established and the zones of contamination identified. Prior to cleanup activities, contamination will be limited to sediments, water, and soil. During construction, new areas may be identified, including the worksite air.

Personal Protection

Level of protection may include Level B and C protection equipment. Those in direct contact with the contaminant shall wear Butyl splash protection aprons; along with neoprene/viton gloves over surgeon gloves; disposable PVC-coated, or better, coveralls over chemically resistant coveralls; and disposable booties over steel toe/shank neoprene boots.

Those workers in areas of PCB levels in the air of 1.0 mg/m^3* or greater shall wear supplied air respirators with full facepiece helmet or hood, or SCBA's with full facepiece, operating in the positive pressure mode. Those in areas less than 1.0 mg/m^3, shall wear full face air-purifying respirators with high efficiency organic vapor/dust canisters or cartridges (respiratory equipment must be NIOSH approved).

Surveillance equipment and other safety equipment will include air sampling pumps with florisil collection tubes, total dust particulate counter or Hi-volume sampler, wind speed and direction device, air escape mask, first aid kit(s), portable emergency eye/face wash, showers and change room.

Decontamination Procedures

Disposables shall be removed at the hotline. All nondisposables shall be washed in the following series: 1) detergent and water solution; 2) clean water rinse. Nondisposable work clothing shall be changed daily and checked for contamination. Any contaminated clothing underneath disposables shall be properly discarded. Wash tubs and/or basins, brushes, decon solution, pressurized sprayers, plastic sheeting for equipment drop, plastic bags, drums, labels, and those items necessary to comply with Federal Industry and Construction Regulations shall be provided.

Site Entry Procedures

Site should be entered from an upwind hotline in the level of protection required for the associated task. Strict contamination avoidance techniques will be practiced by all personnel onsite.

---

*Note: NIOSH currently recommends an "action level" of 1 microgram/cubic meter in ambient air for requiring the use of supplied air/SCBA. The above-referenced "action levels" refer to current OSHA standards for exposure to chlorodiphenyl (42% chlorine).

Work Limitations (Time of Day, Etc.)

In daylight hours, heat stress must be carefully watched, and appropriate alteration of work activities should be incorporated, i.e., work shifts, time-of-day shifts.

Investigation-Derived Material Disposal

All disposable clothing and materials that are potentially contaminated must be properly bagged and labelled and disposed of properly. All contaminated sediments, soils, and liquids that leave the site must meet all Federal D.O.T. and State of Illinois Regulations. All onsite equipment such as heavy excavation and dredging equipment must be properly decontaminated prior to leaving the designated hot zones.

SUMMARY

This is a conceptual site safety plan, and does not include the detailed information that would be incorporated in a final site safety plan for the OMC site. Additional information should be developed when final remedial alternatives are better defined. Additional information to be developed includes:

- Local resources for emergency situations
- Emergency routes (hospital, etc.)
- Delineated responsibilities
- Provisions for contingencies
- Site layout and zones of contamination
- Detailed level of protection per specific site activity
- Detailed access and egress points
- Detailed air monitoring activities